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THEORETICAL CALCULATIONS OF THE PHENOMENOLOGY OF HE DETONATIONS

Volume II

William A. Whitaker, Captain, USAF
Edmund A. Nawrocki, Captain, USAF
Charles E. Needham
William W. Troutman

TECHNICAL REPORT NO. AFWL-TR-66-141, Vol. II

November 1966

AIR FORCE WEAPONS LABORATORY
Research and Technology Division
Air Force Systems Command
Kirtland Air Force Base
New Mexico

Best Available Copy

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— FOREWORD

This research was performed under Program Element 7.60.08.01.D, Project 5710, Subtask 1.027, and was funded by the Defense Atomic Support Agency (DASA).

Inclusive dates of research were 1 September 1965 to 1 June 1966. The report was submitted 27 October 1966 by the Project Officer, Capt William A. Whitaker (WLRTH).

This report has been reviewed and is approved.

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ABSTRACT

The phenomenology of two atmospheric high-explosive detonations were calculated theoretically. The first was a 20-short-ton spherical charge of TNT (loading density--1.56 gms/cc). The second was a methane-oxygen mixture (mole ratio 1 to 1.5) contained in a 55-ft-radius balloon. Both detonations took place at an altitude of 670 meters (ambient pressure 13.6 psi) with a reflecting surface 85 feet below burst point. The calculations, taken out to 300 milliseconds after detonations, were performed by using SAP, a one-dimensional Lagrangian hydrodynamic code and SHELL-OIL, a two-dimensional pure Eulerian hydrodynamic code. Volume II of this report contains the details of the results in graphical form. Included are pressure and density contours, velocity vector plots, and wave forms for 19 test stations.

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CONTENTS

<u>Section</u>		<u>Page</u>
I	INTRODUCTION	1
II	THE TNT CALCULATION	3
III	THE METHANE CALCULATION	183
	DISTRIBUTION	357

AFWL-TR-66-141, Vol. II

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SECTION I

INTRODUCTION

Volume II is divided into three sections, the last two of which are, in turn, divided into three parts.

Section II contains plots of the TNT calculations. Part 1 consists of profiles of the thermodynamic variables at selected times as calculated by SAP. Part 2 consists of pressure and density contours and velocity vectors at selected times as calculated by SHELL-OIL. Part 3 consists of traces of overpressure, dynamic pressure impulse, radial velocity and axial velocity as a function of time at the various test stations; again, the results of SHELL-OIL.

Section III contains plots of the methane calculation. The format of this section is the same as in Section II: first, SAP profiles; second, SHELL-OIL contours and velocity vectors; third, SHELL-OIL tracings at the test stations.

The output contained in this volume is small compared to that available. More detailed, or additional output, in graphical form is available upon request to AFWL (WLRTS).

Table I

POSITION OF TEST STATIONS

Test Stations	Range		Altitude	
	Meters	(Feet)	Meters	(Feet)
1	0		0	
2	7.62	(25)	0	
3	15.24	(50)	0	
4	24.38	(80)	0	
5	38.0	(125)	0	
6	50.0	(164)	0	
7	63.8	(209)	0	
8	78.0	(256)	0	
9	93.3	(306)	0	
10	26.0	(85)	2.8	
11	38.0	(125)	2.8	(9)
12	50.0	(164)	2.8	(9)
13	38.0	(125)	7.6	(25)
14	50.0	(164)	7.6	(25)
15	63.8	(209)	7.6	(25)
16	50.0	(164)	15.2	(50)
17	63.8	(209)	18.0	(59)
18	78.0	(256)	15.2	(50)
19	78.0	(256)	22.8	(75)

SECTION II

THE TNT CALCULATION

SAP Profiles

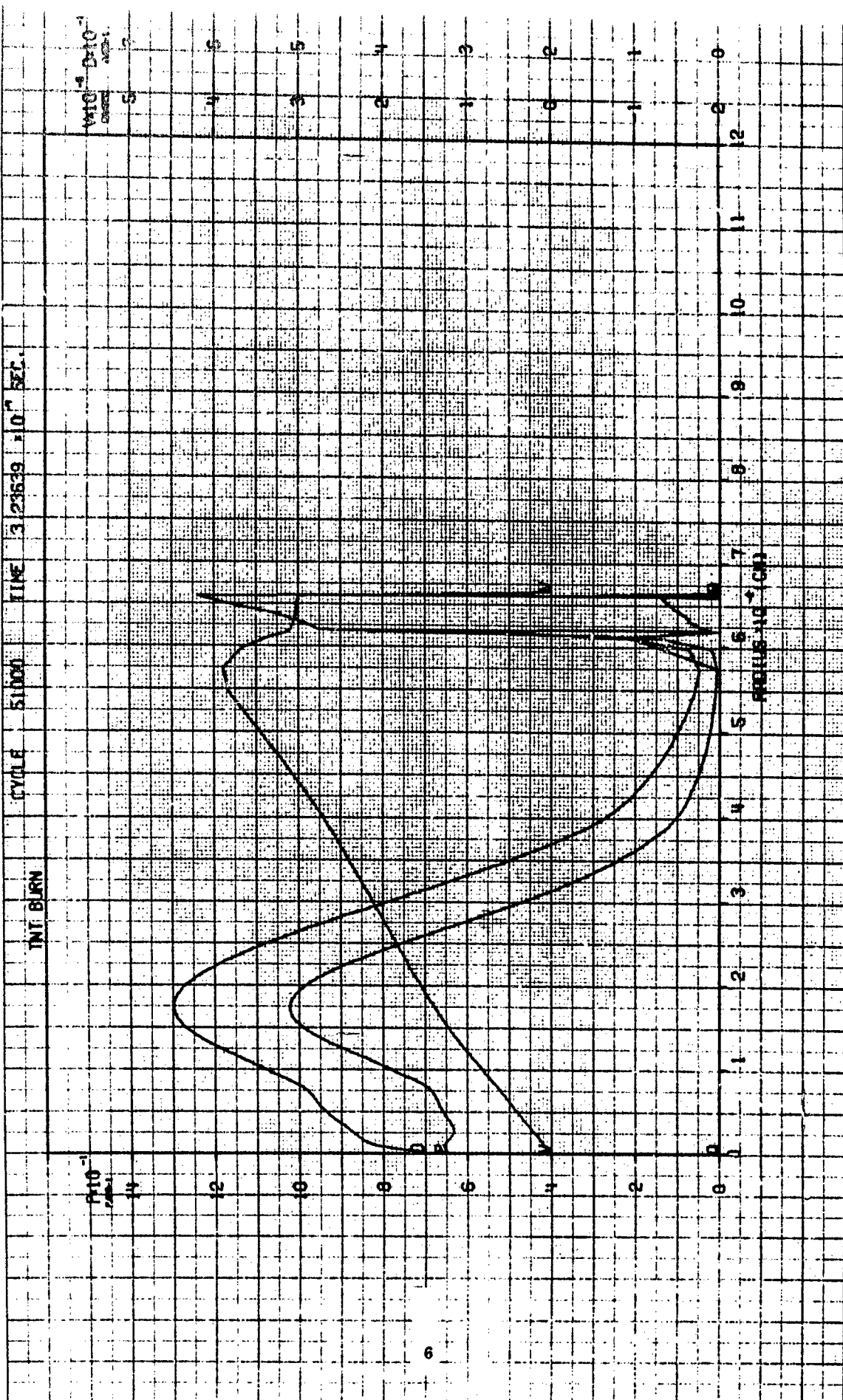
This part contains profiles of pressure, density, and velocity as calculated by SAP for the TNT detonation scaled to 20 short tons. There are plots for 25 different times.

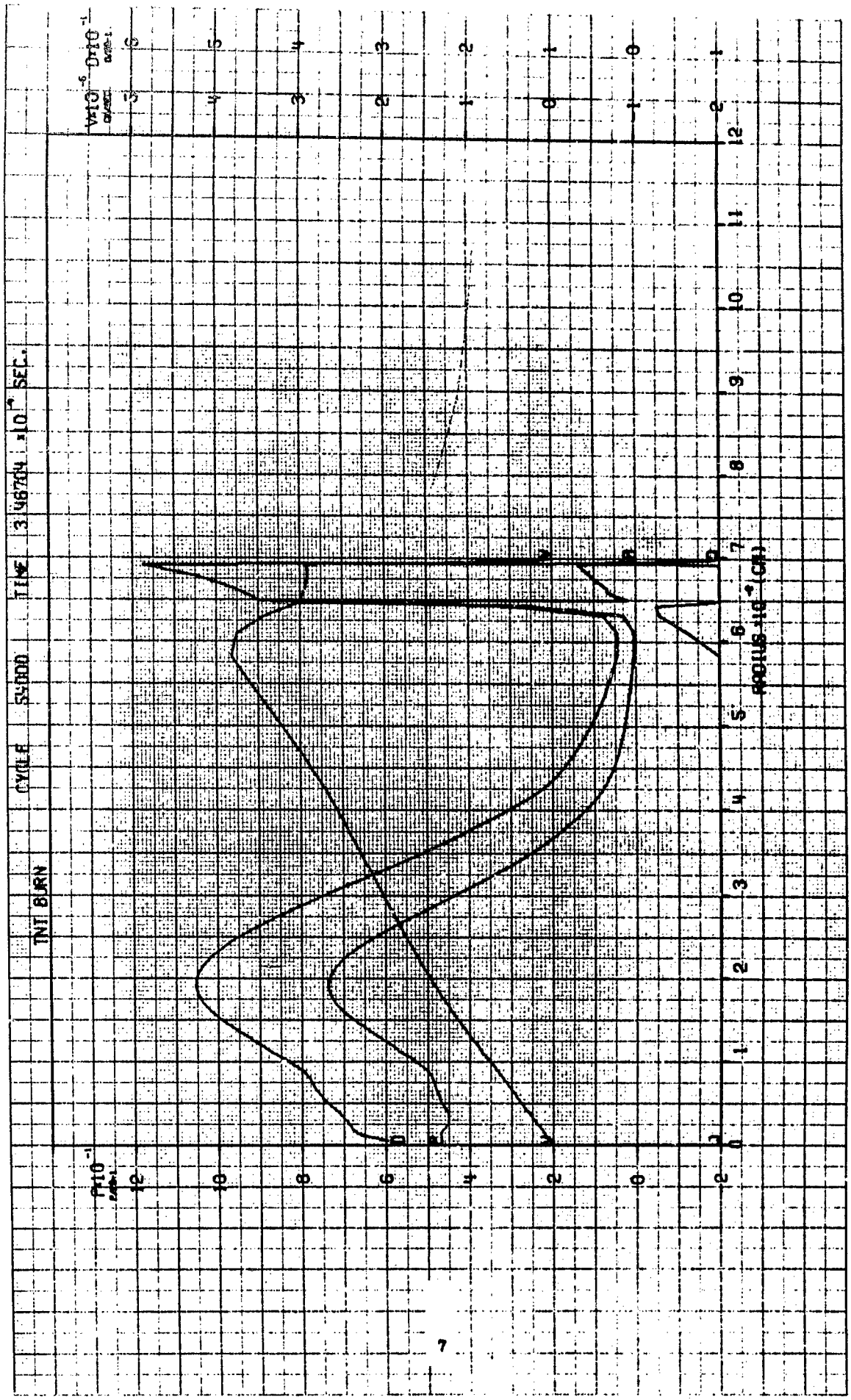
The first plot contains the profiles describing the flow field behind the detonation front in the TNT. Also shown on this plot, as indicated by the symbols, is the similarity solution for the detonation wave, obtained using the LSZK equation of state for TNT. Agreement between the SAP "burn" calculation, which provides a nonself-similar solution, and the similarity solution is excellent.

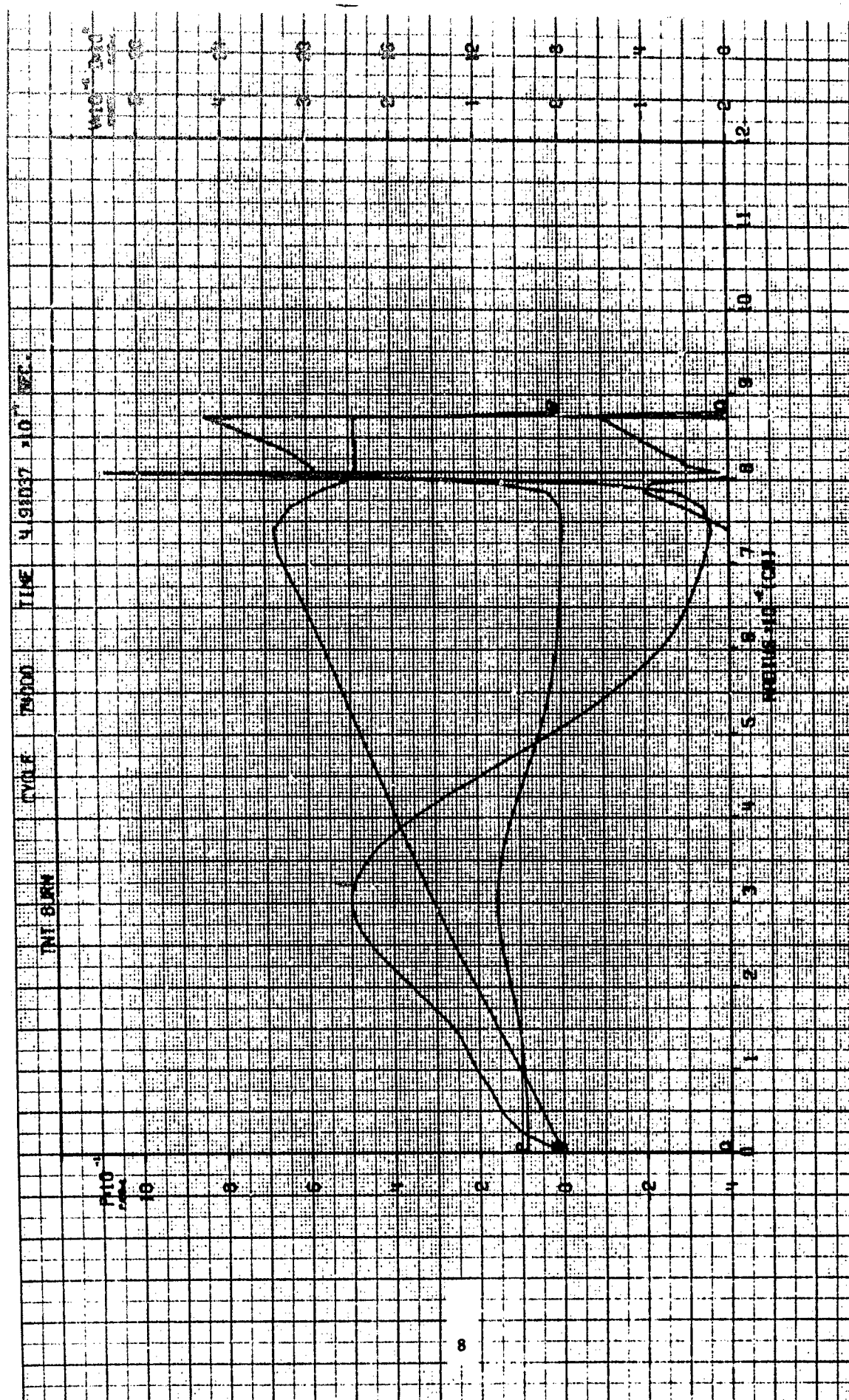
Succeeding plots show the convergence of the rarefaction wave on the origin, the formation and expansion of the free-air shock, and the formation and motion of secondary shocks.

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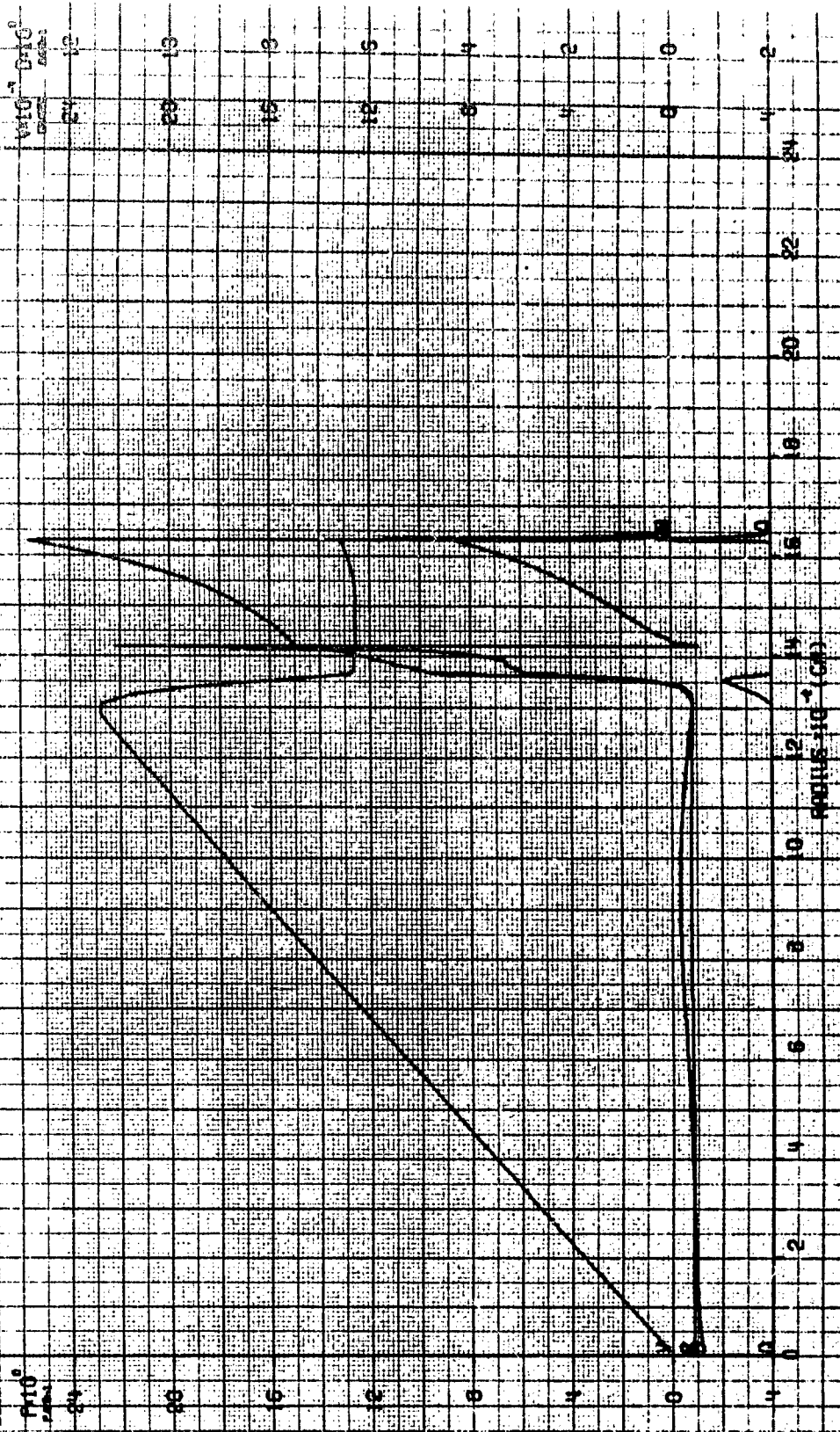


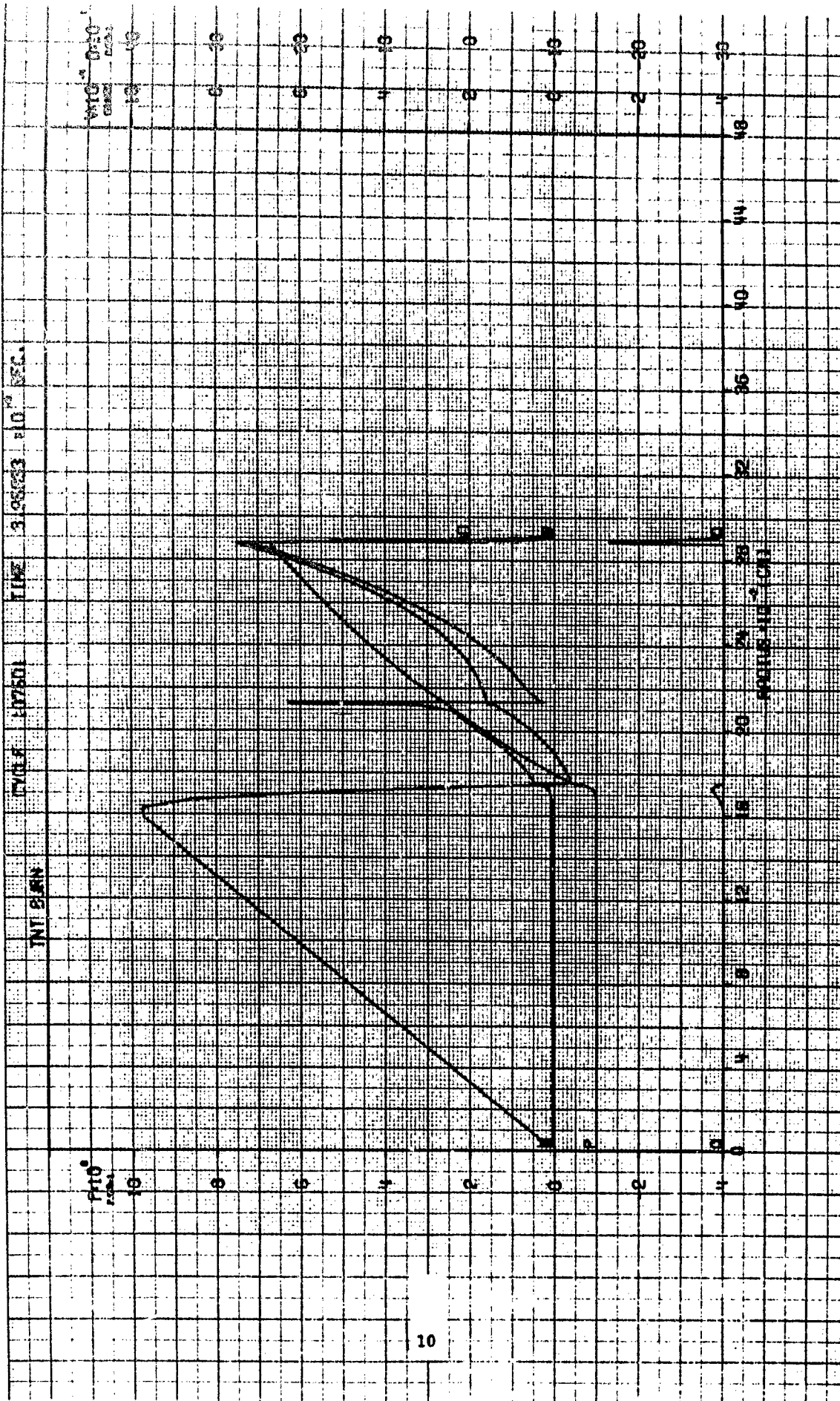


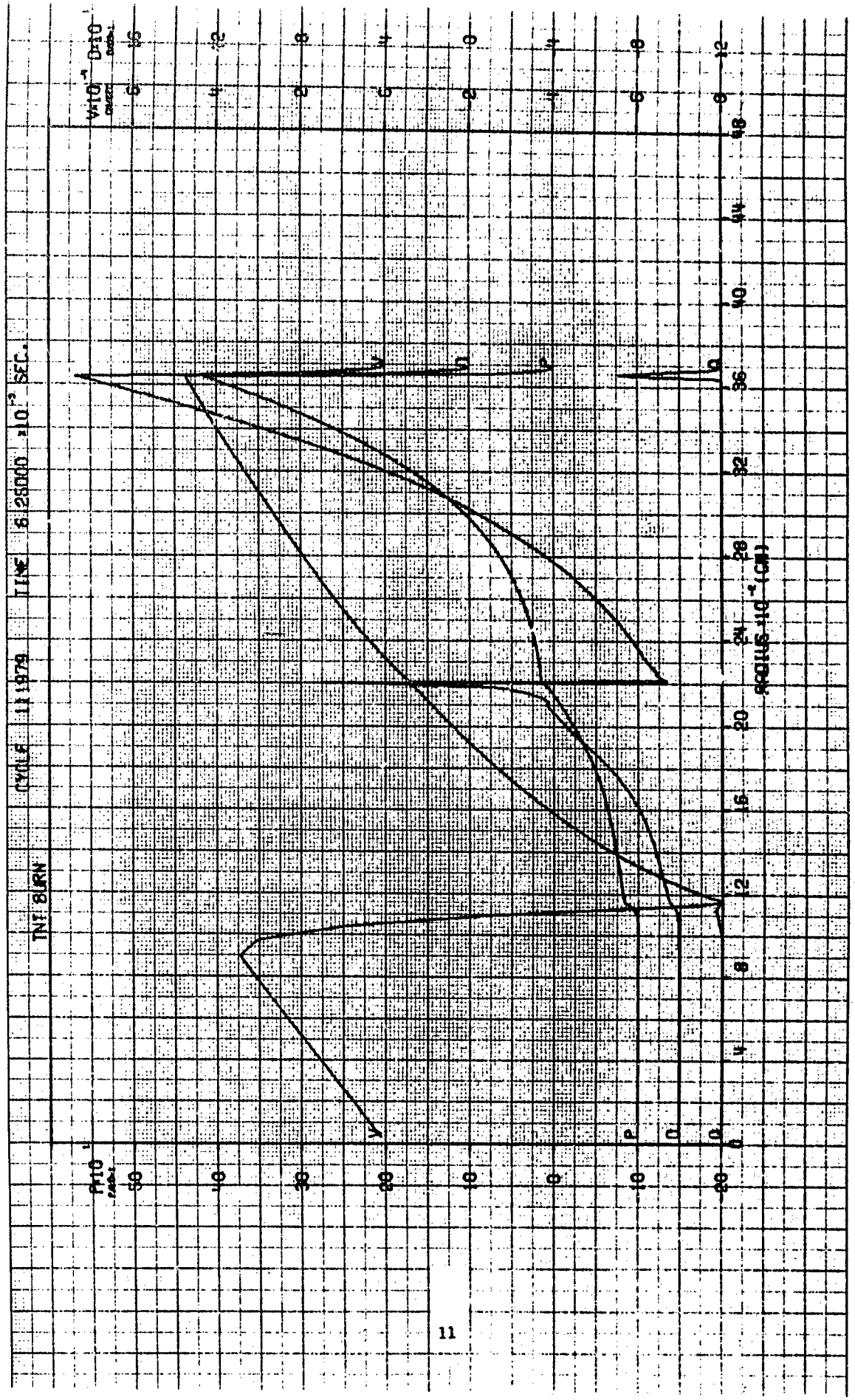
TIME 1.37368 $\times 10^{-3}$ SEC.

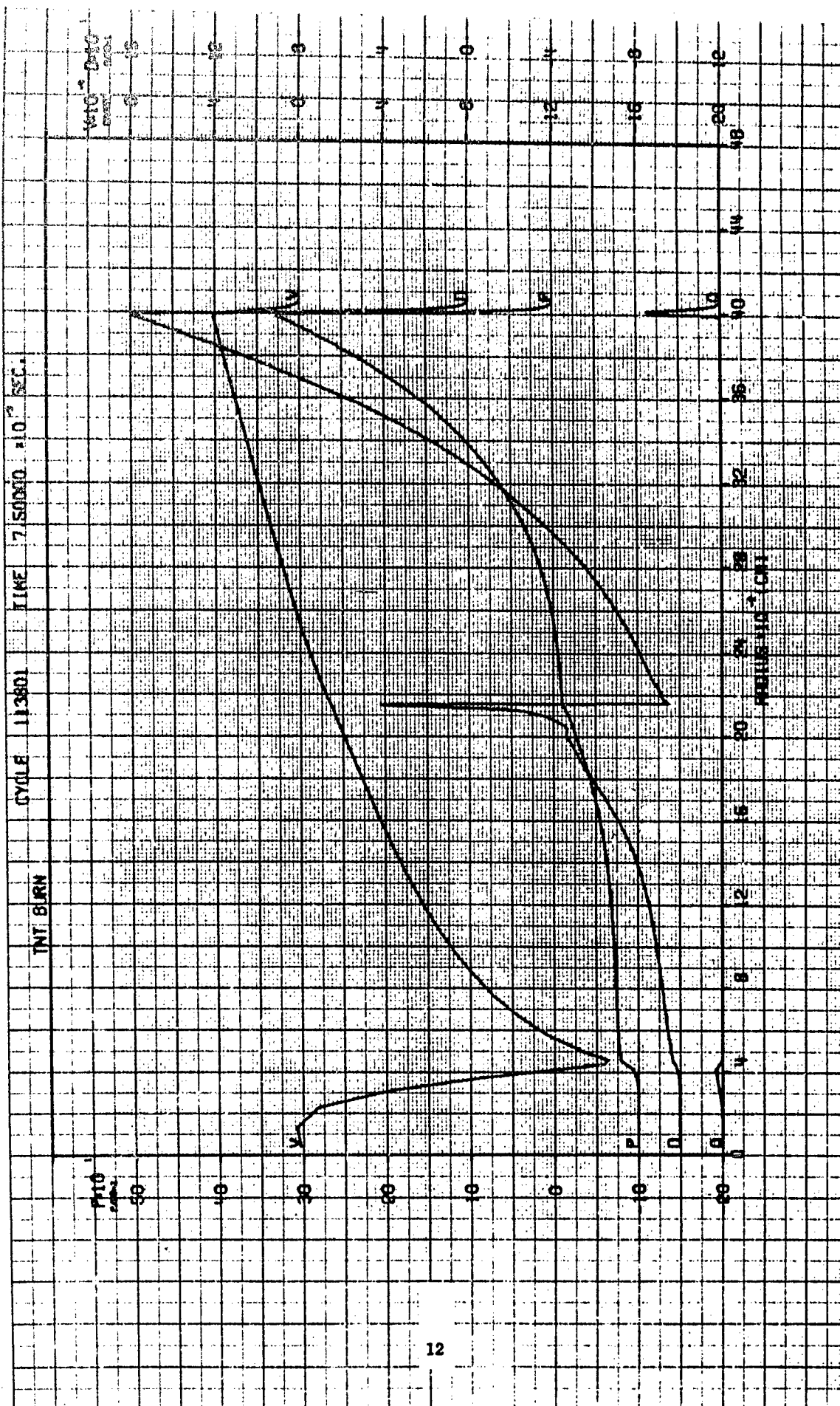
CYCLE 39000

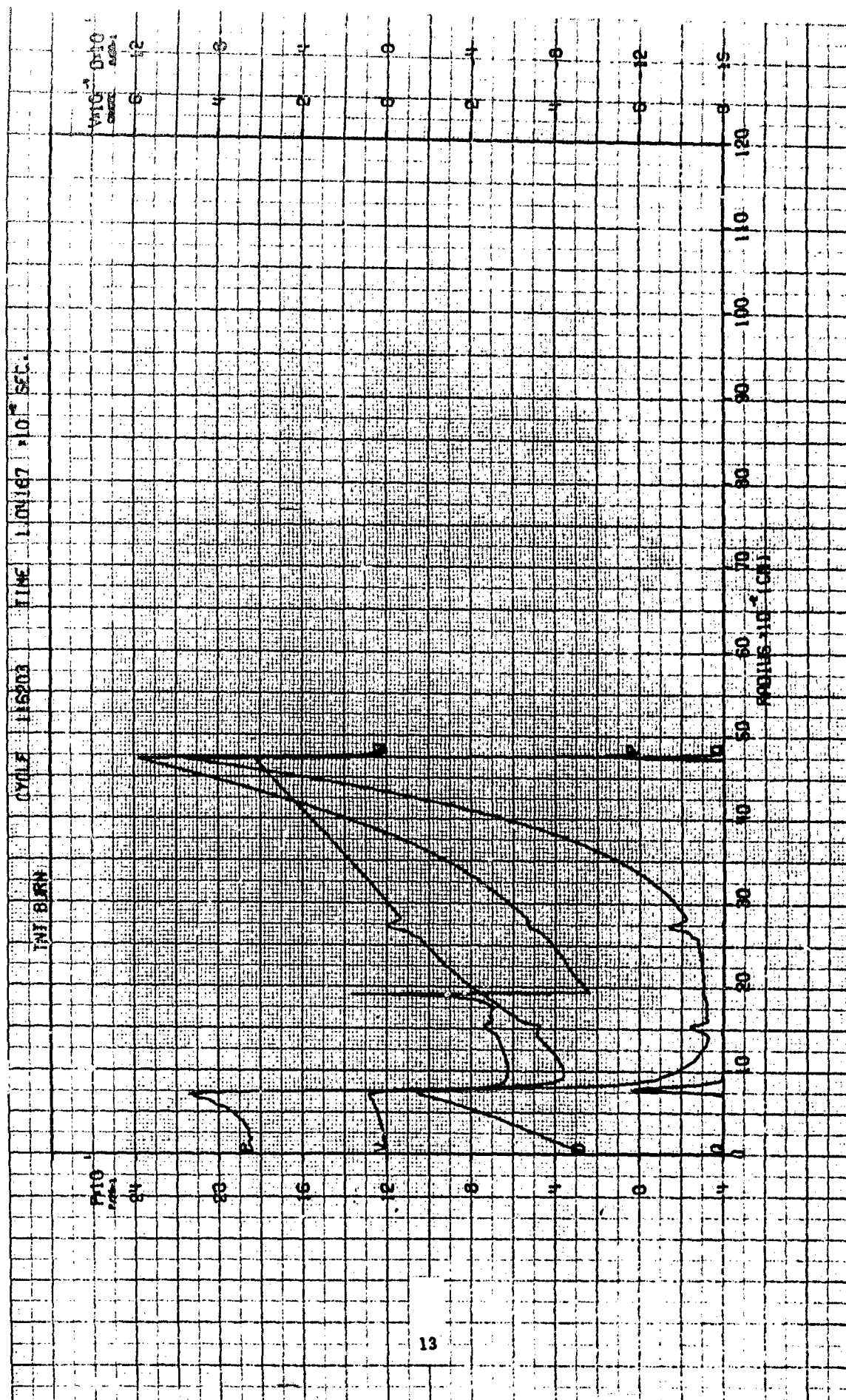
INT BURN

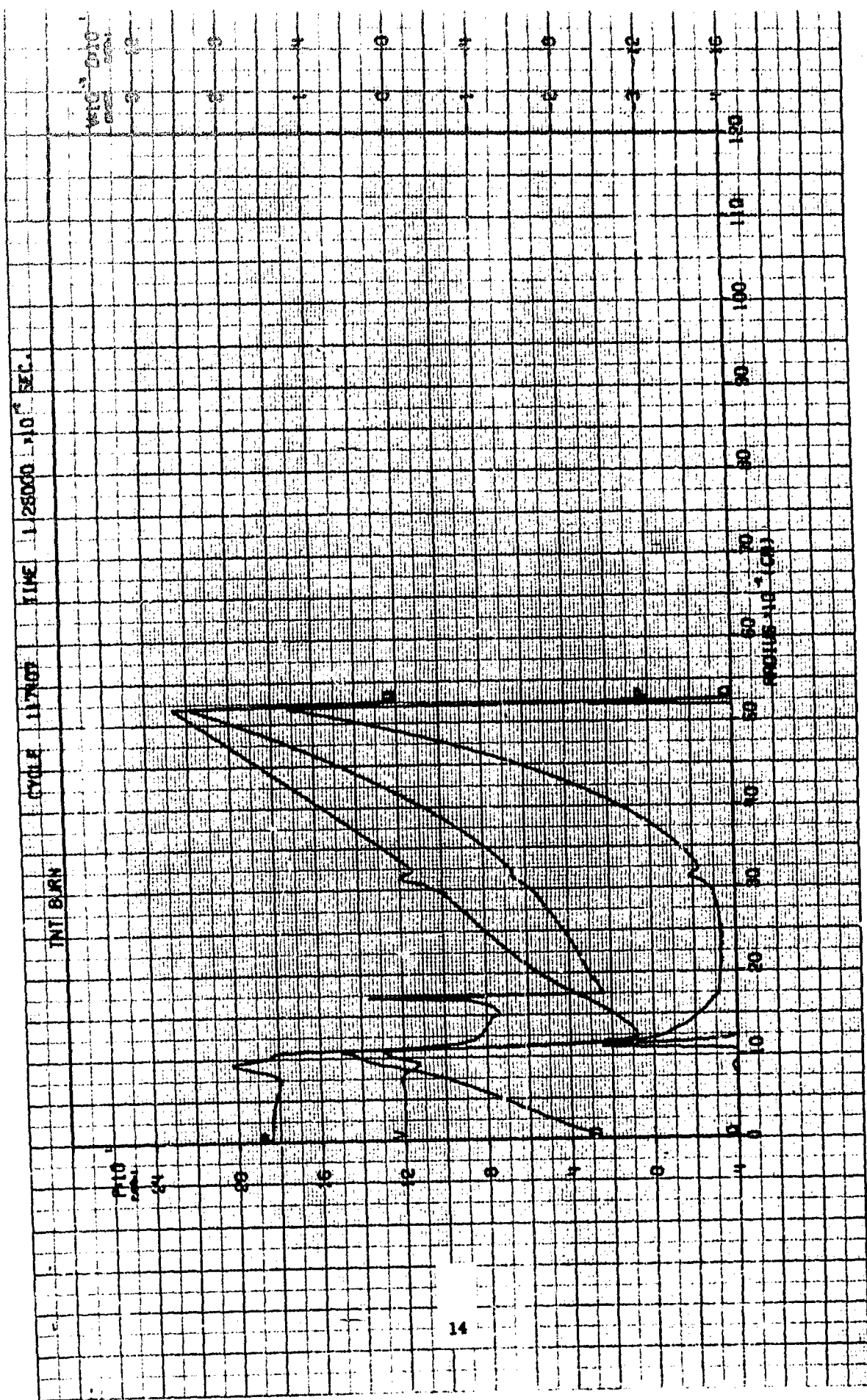


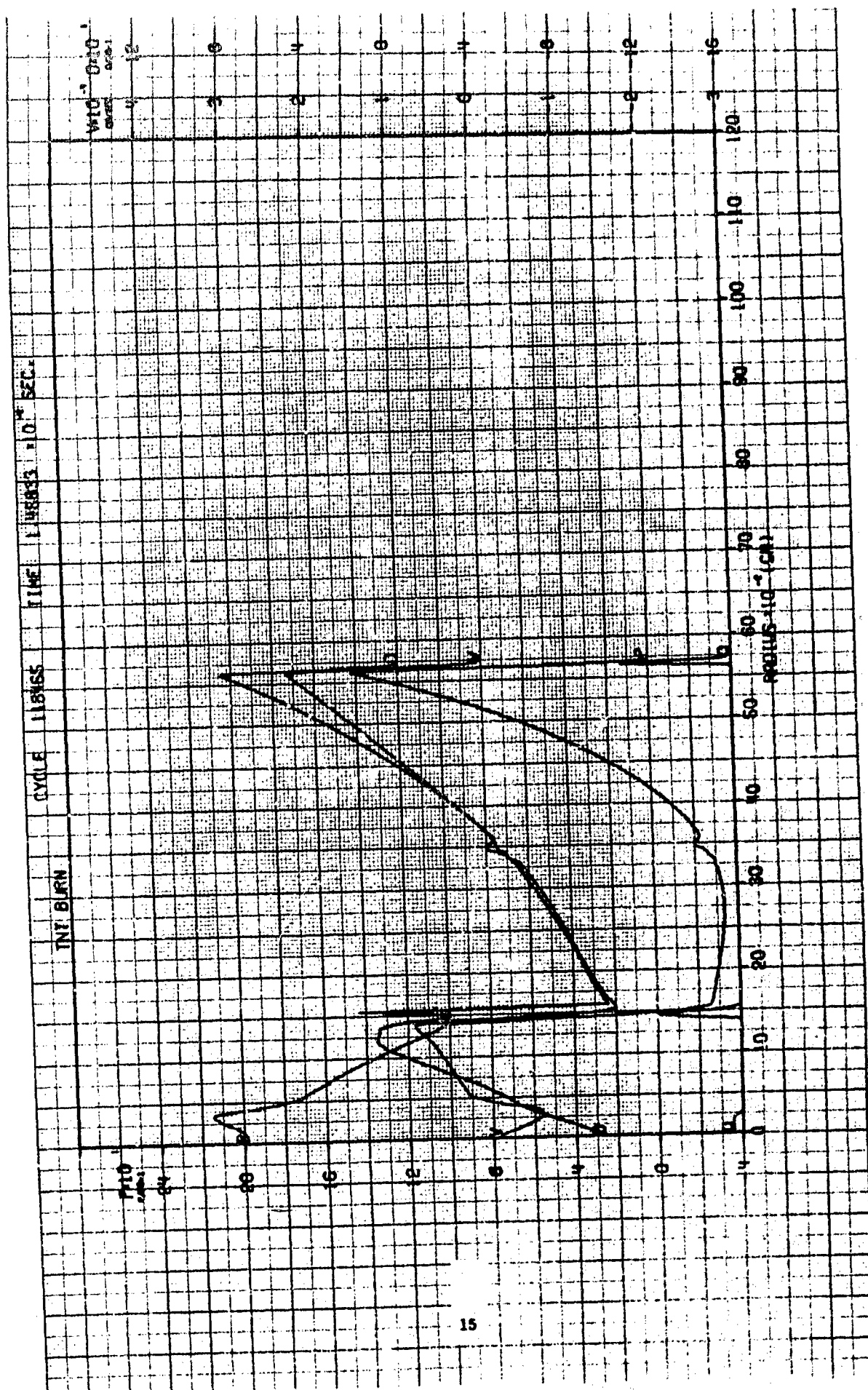


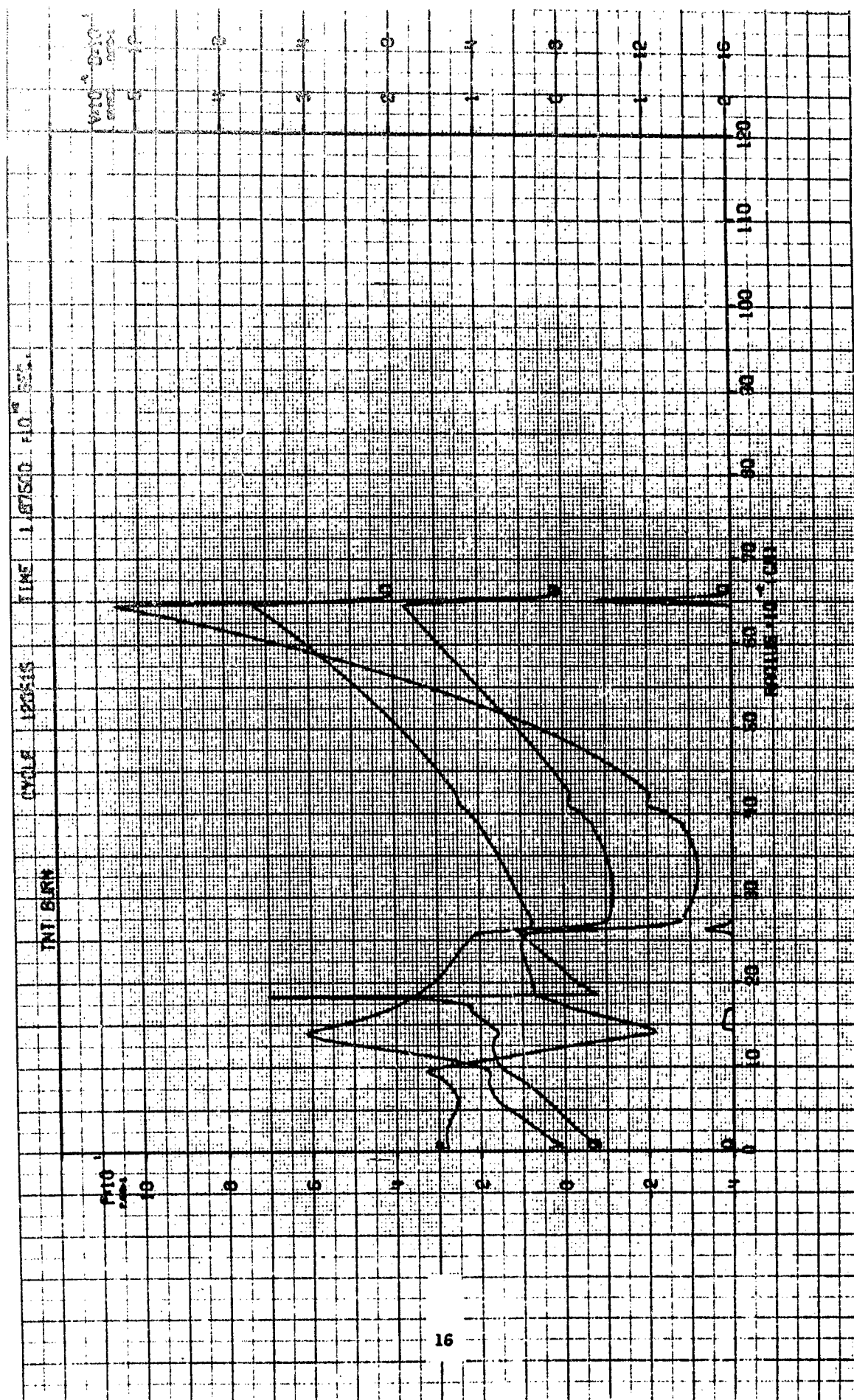


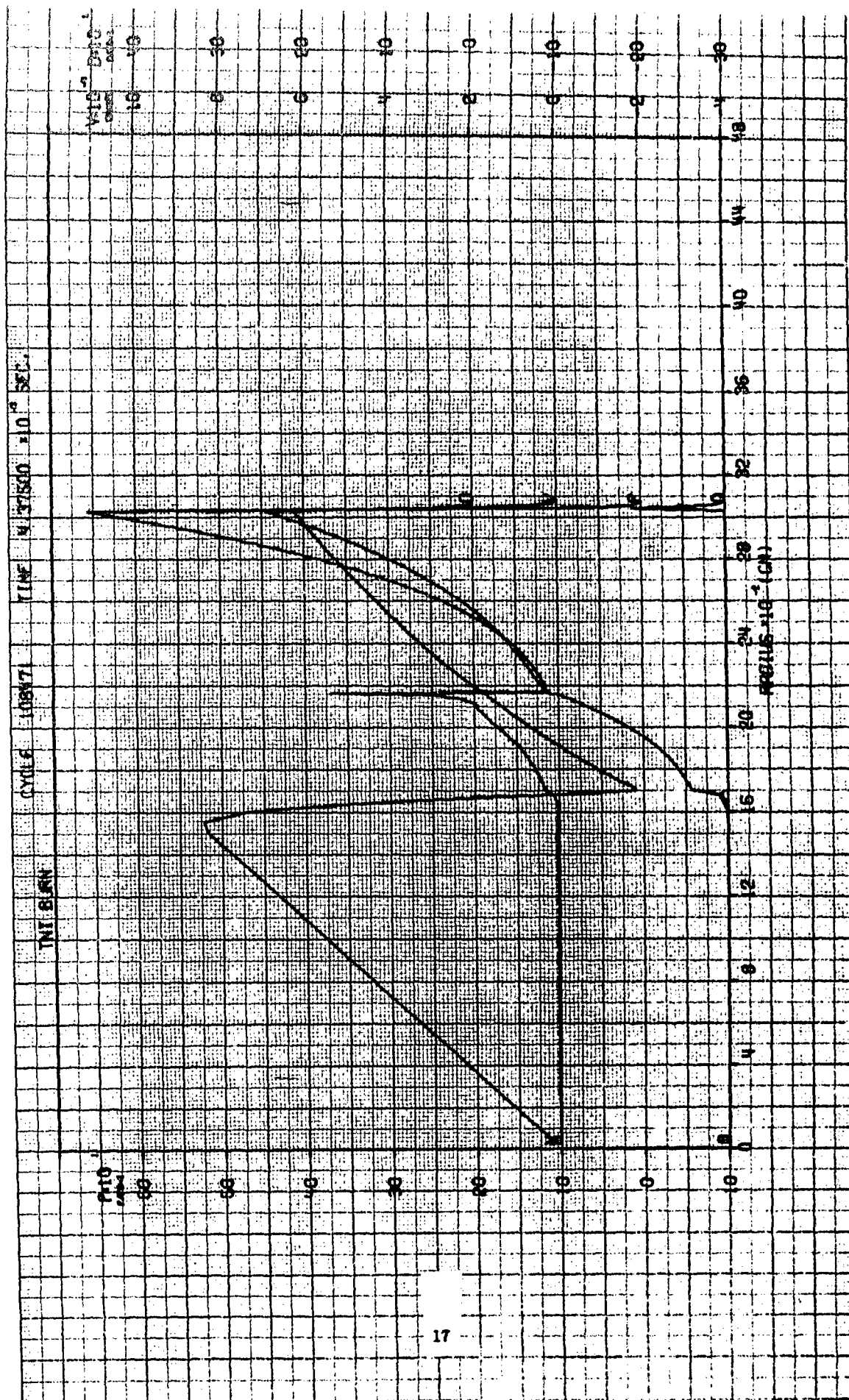




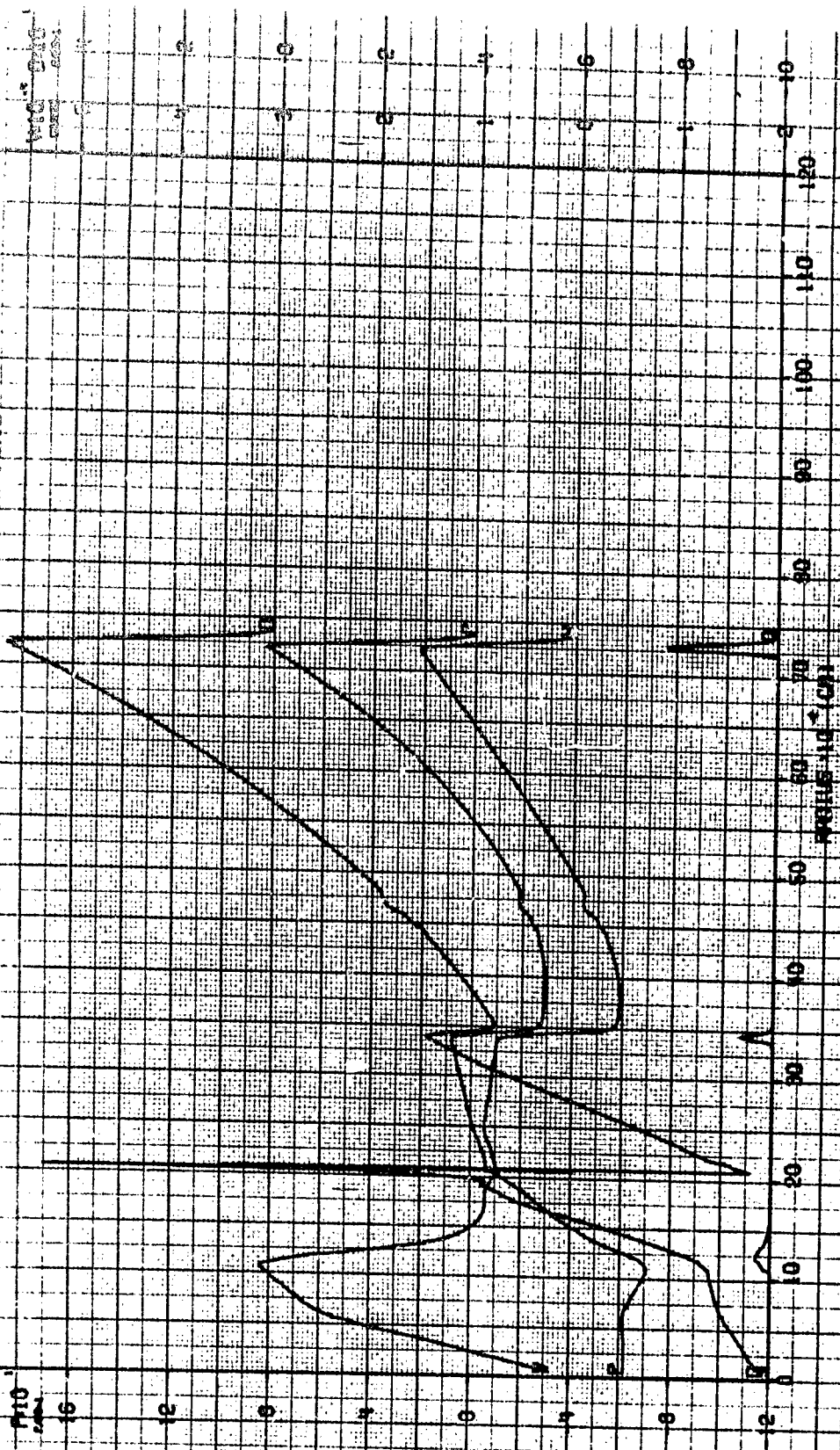


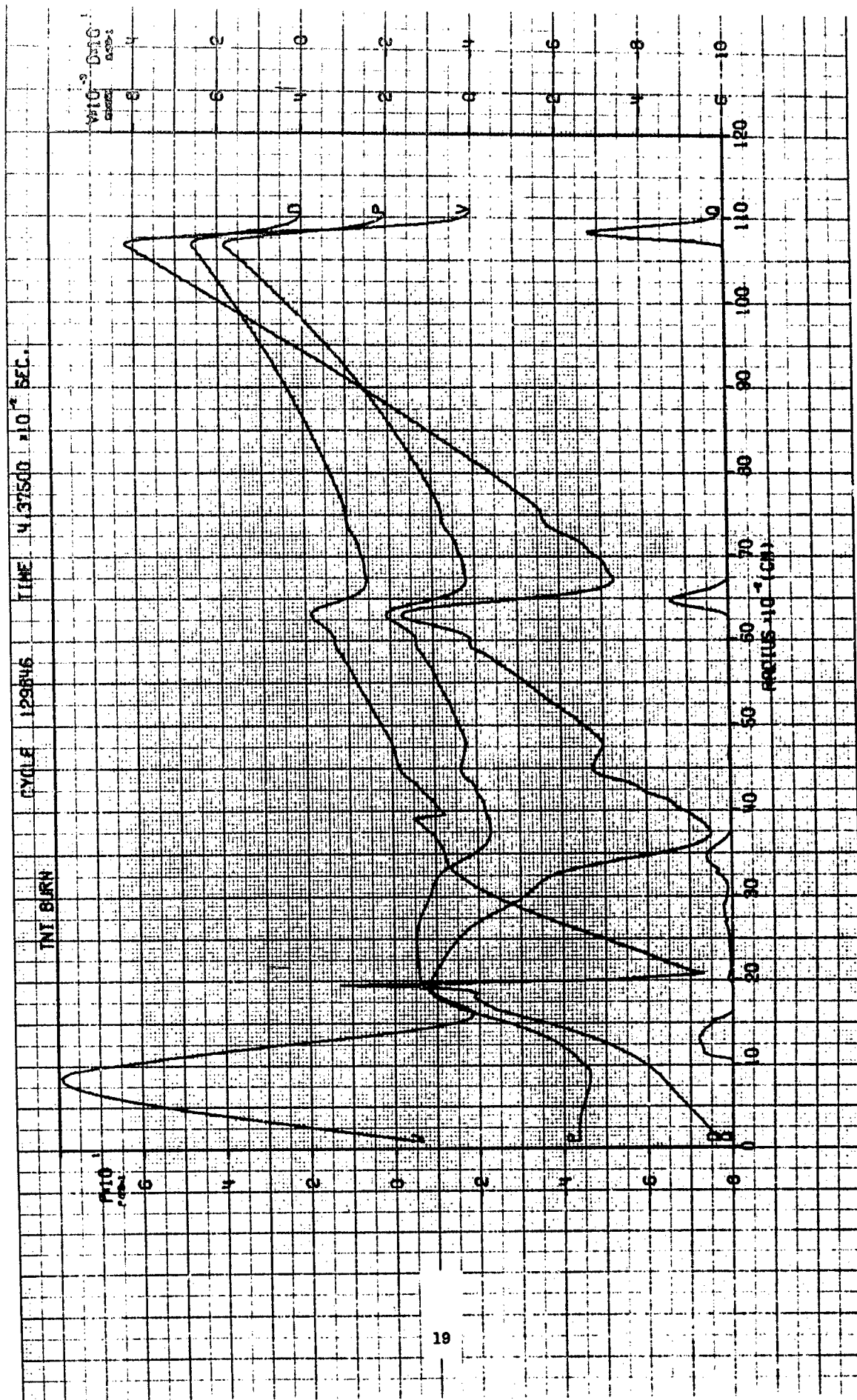


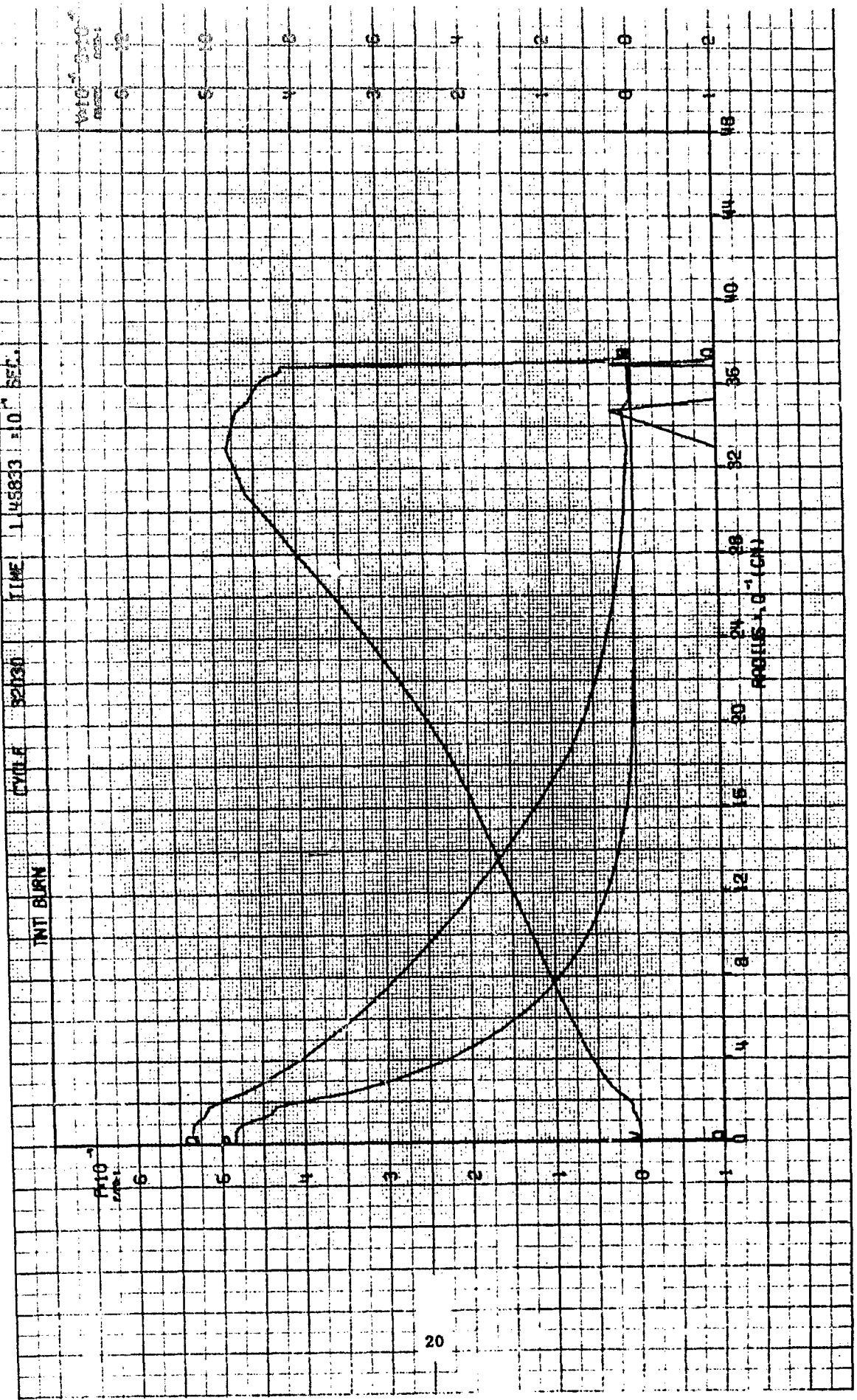


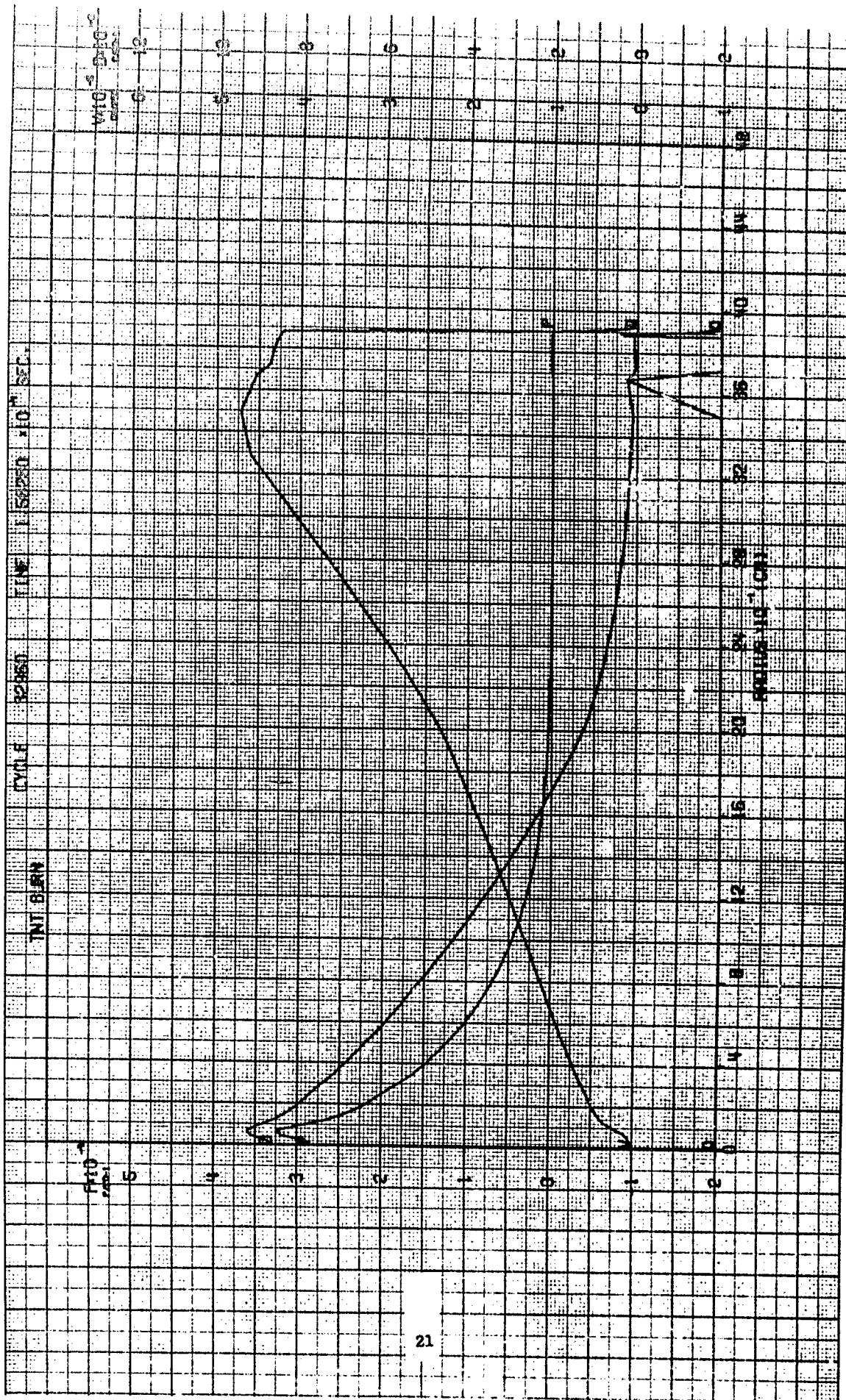


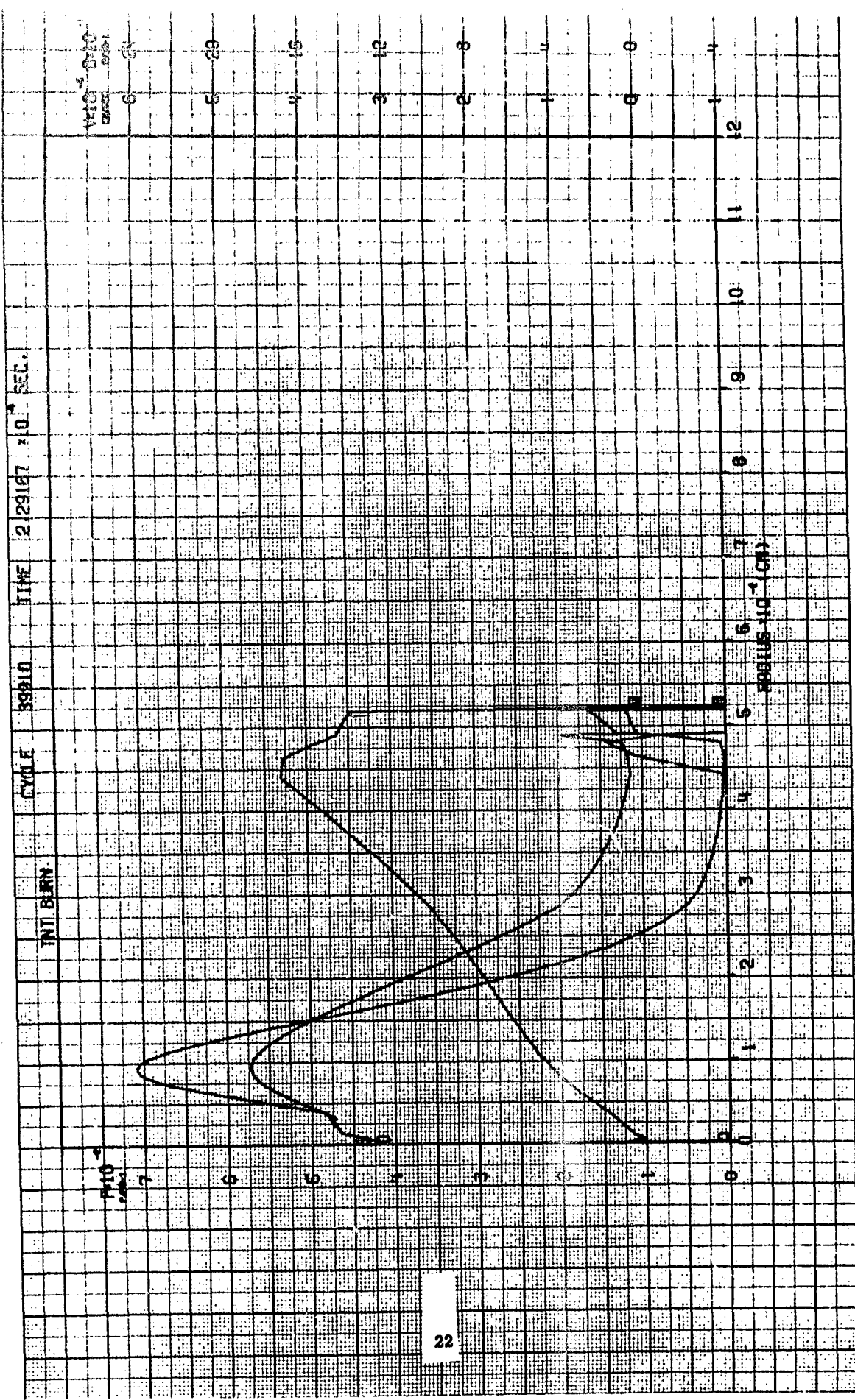
TNT BURST CYCLE 123094 TIME 2:29:57 ± 0.5 sec.

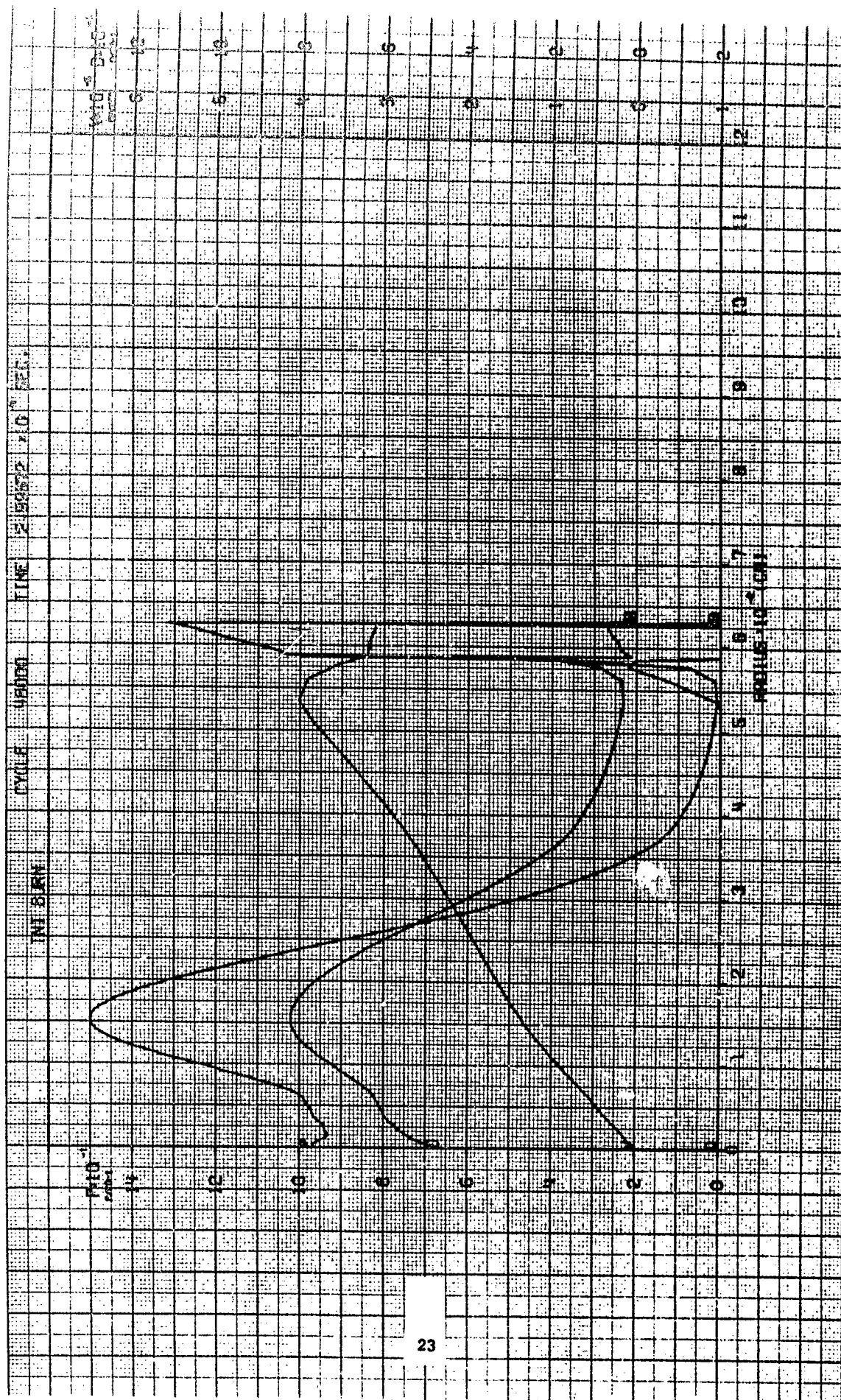


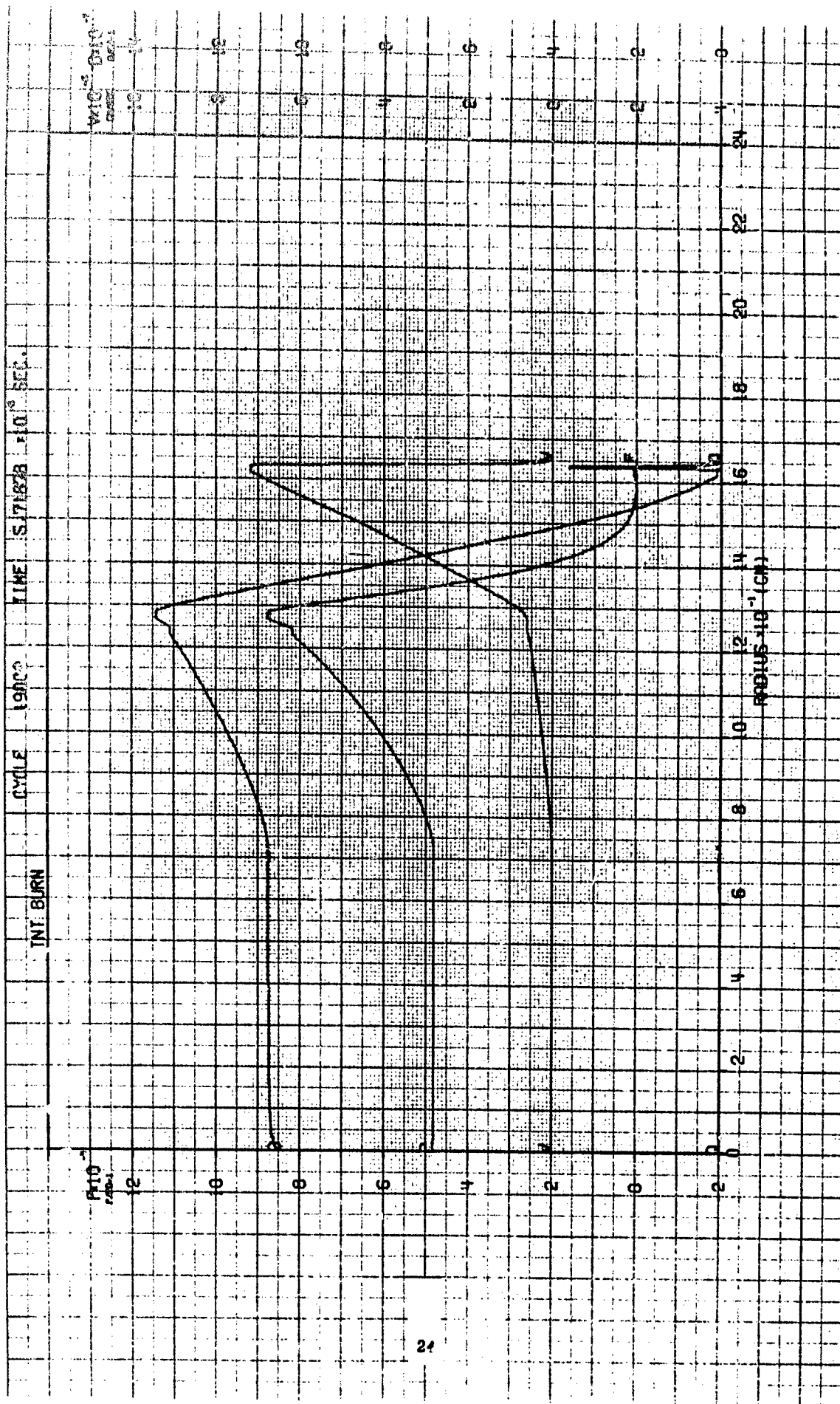


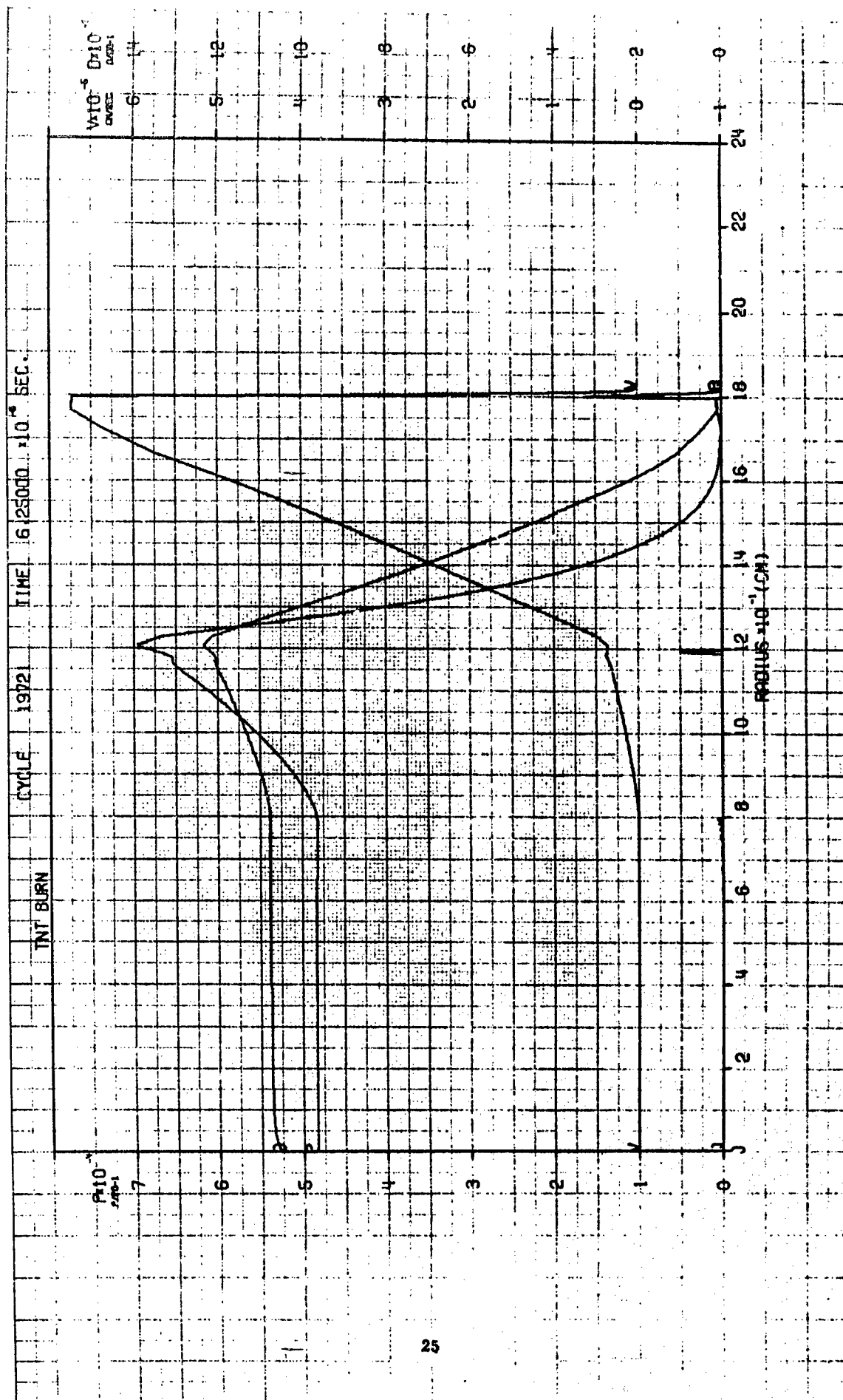


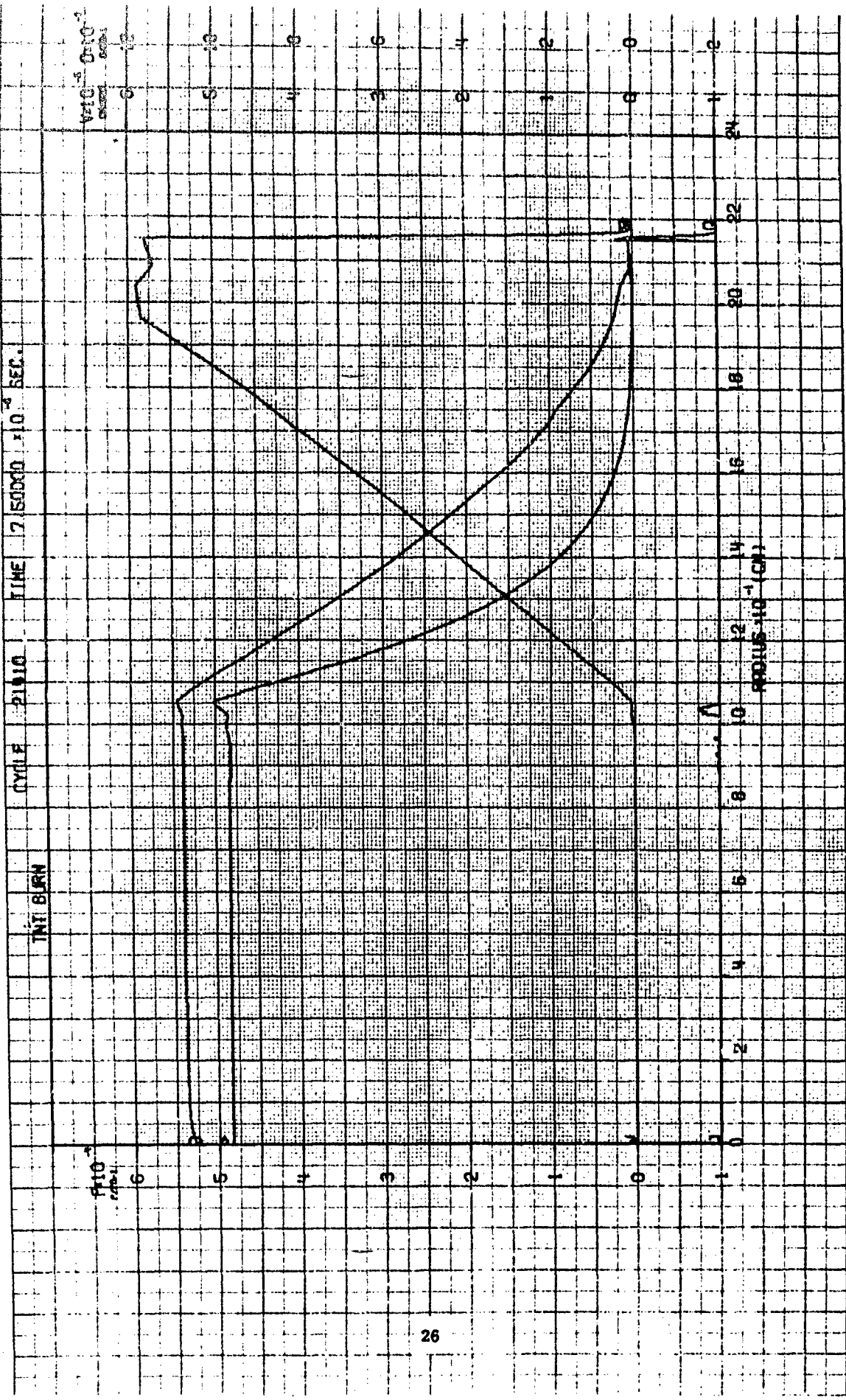


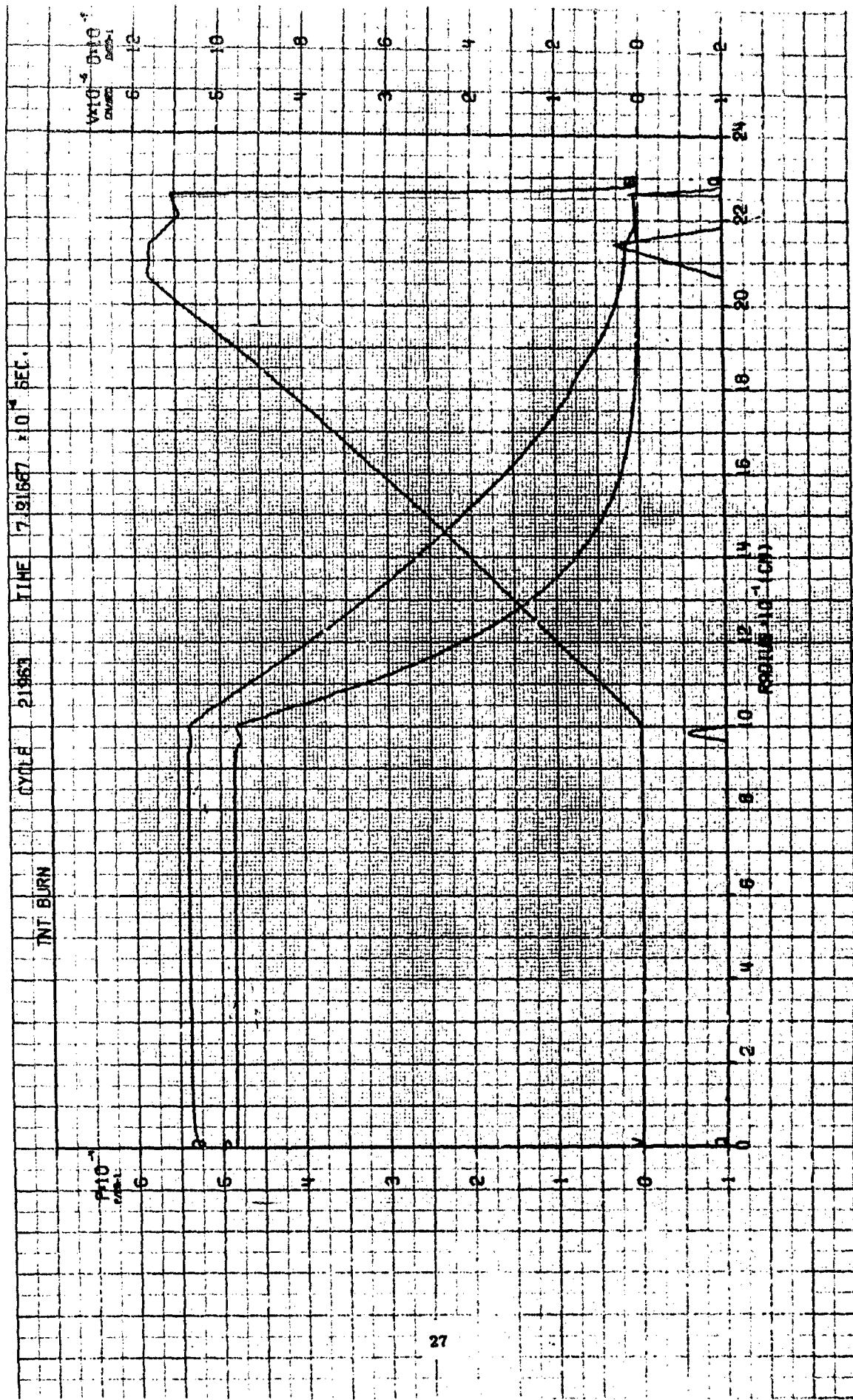


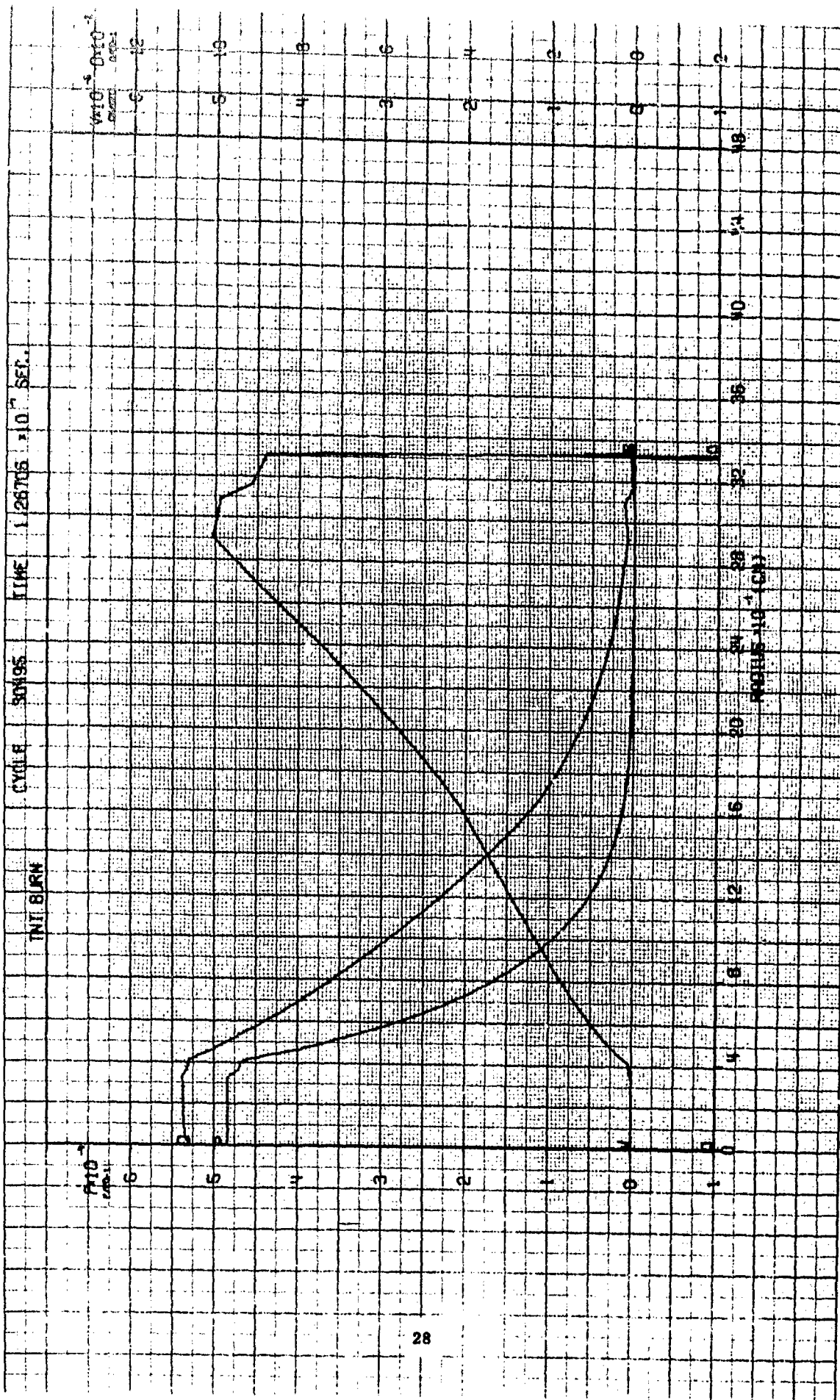


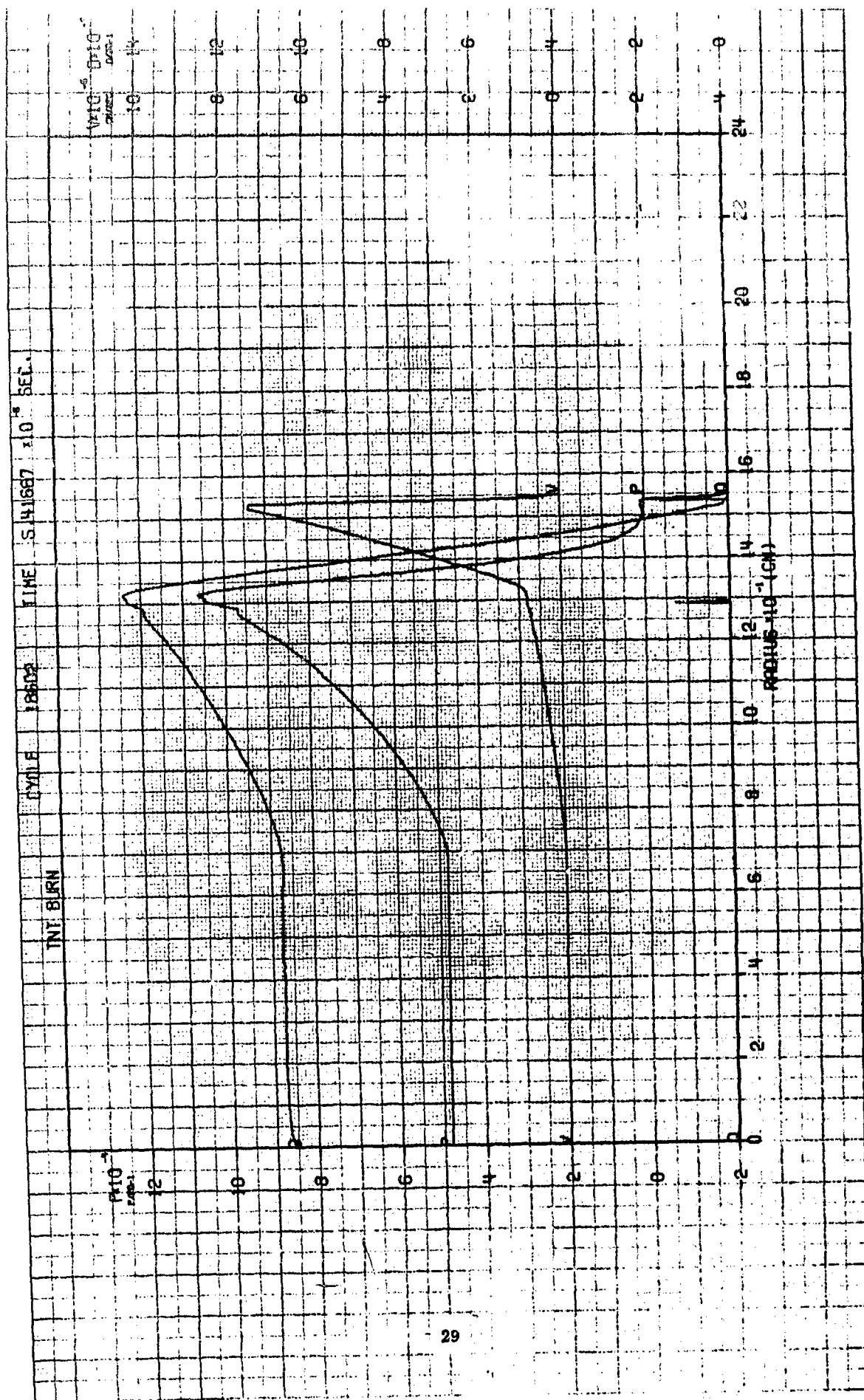












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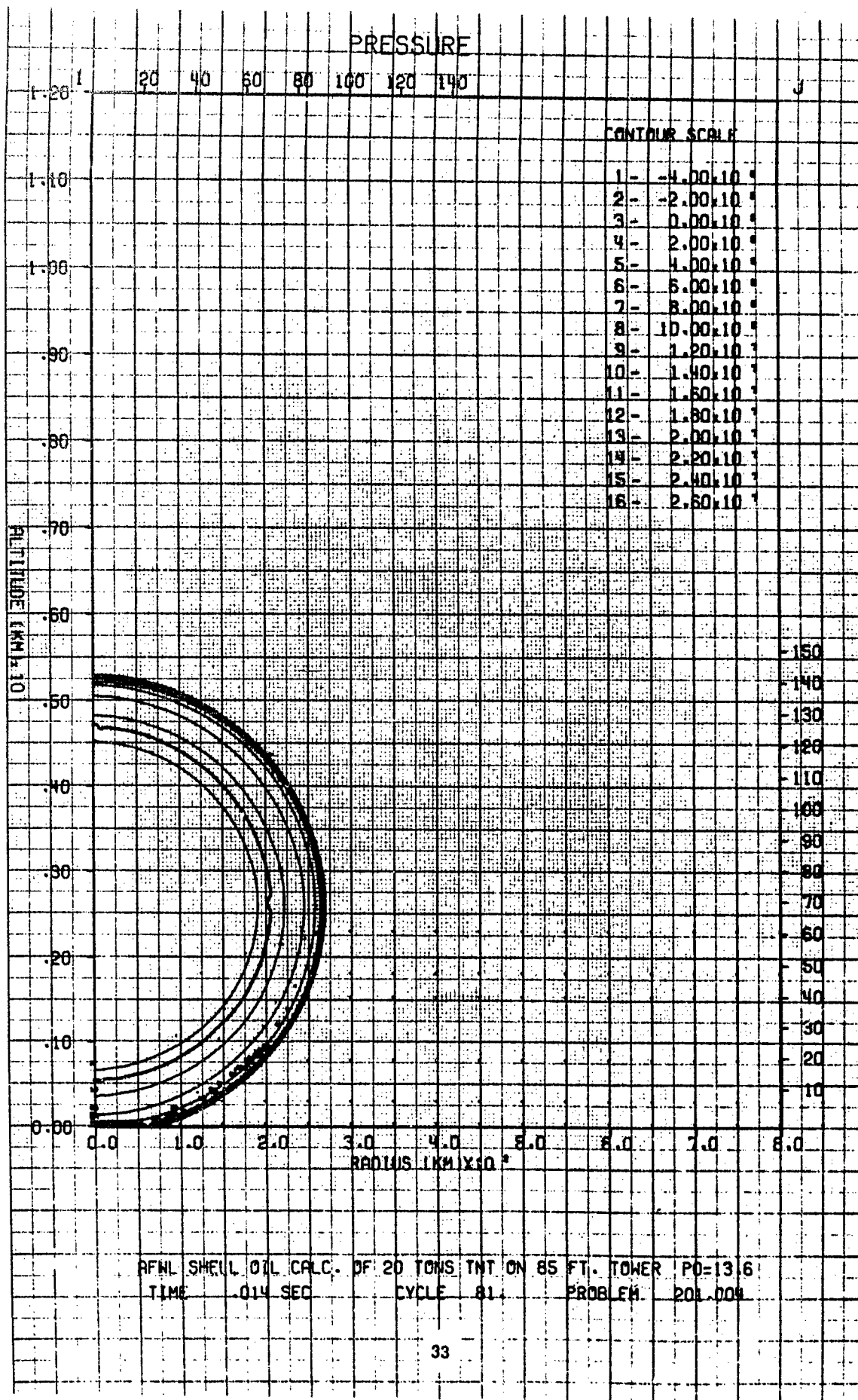
SHELL Contours and Velocity Vectors

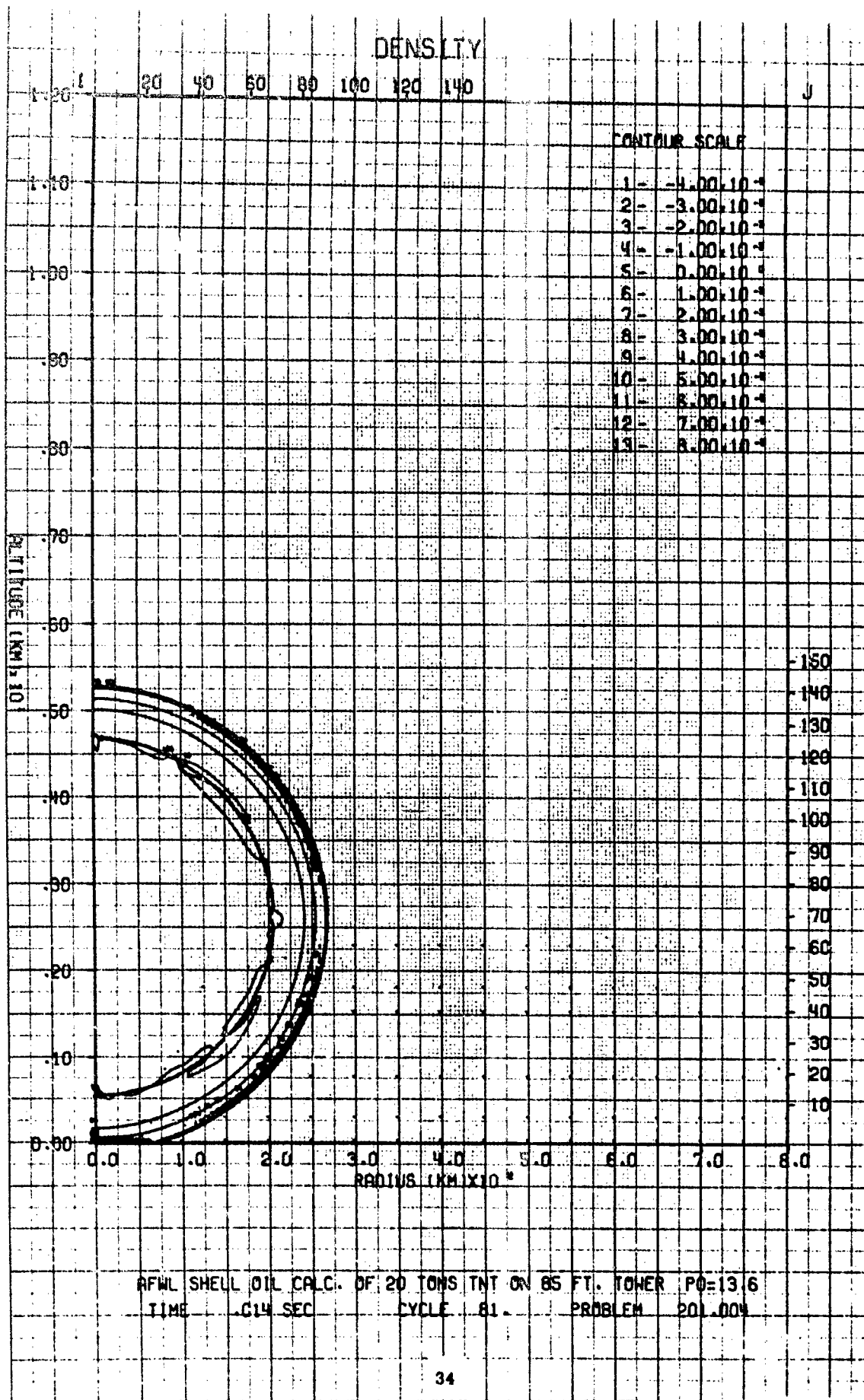
This part contains pressure and density contours and velocity vector plots of the results of the SHELL-OIL calculation of the TNT detonation (20 short-tons). There are plots for 8 different times.

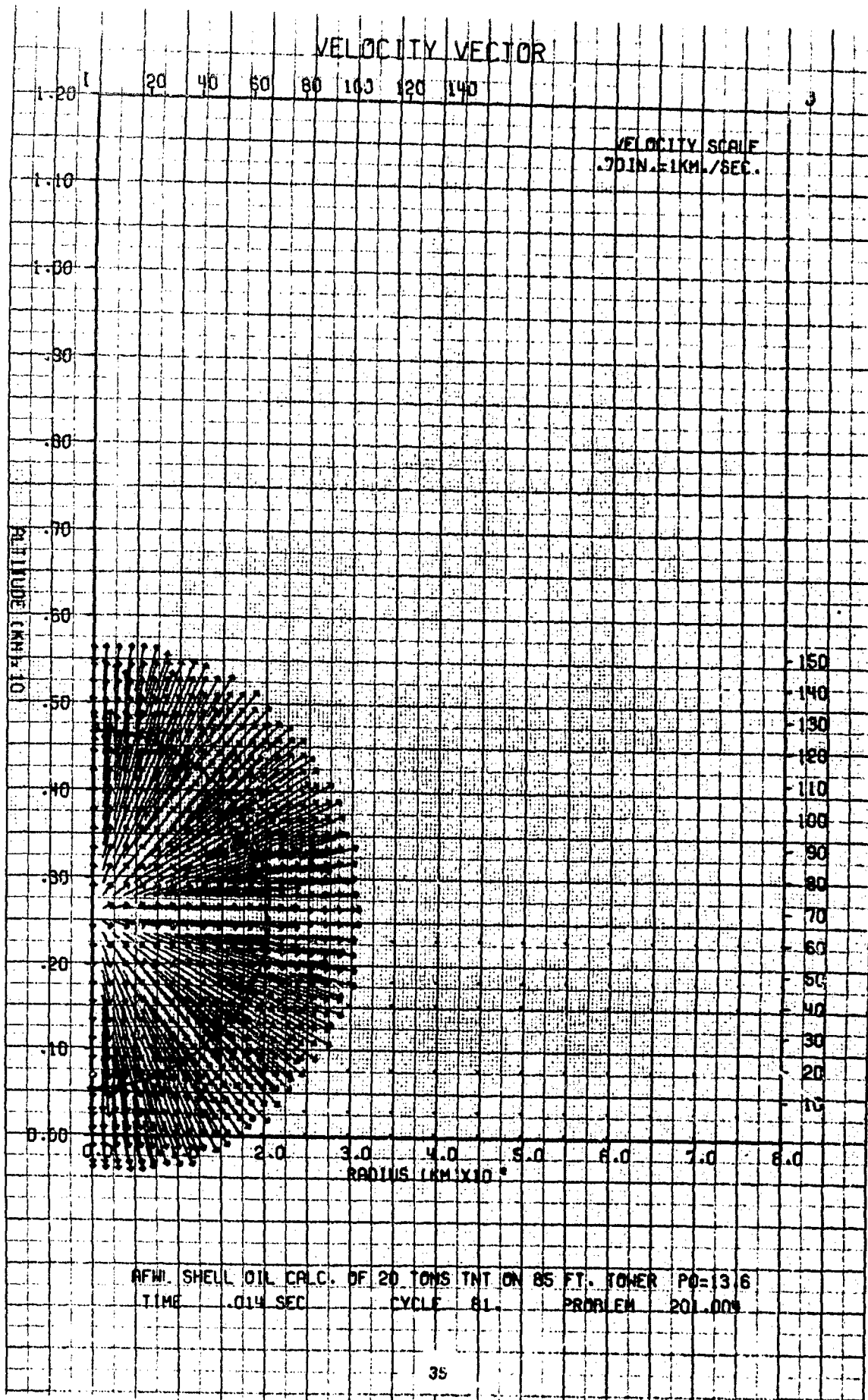
The first plot shows the reflection of the free-air shock at the ground. Subsequent plots show the formation and movement of the triple point and mach stem. The heavy black line on each plot shows the location of the massless trace particles that represent the TNT-air interface at that time.

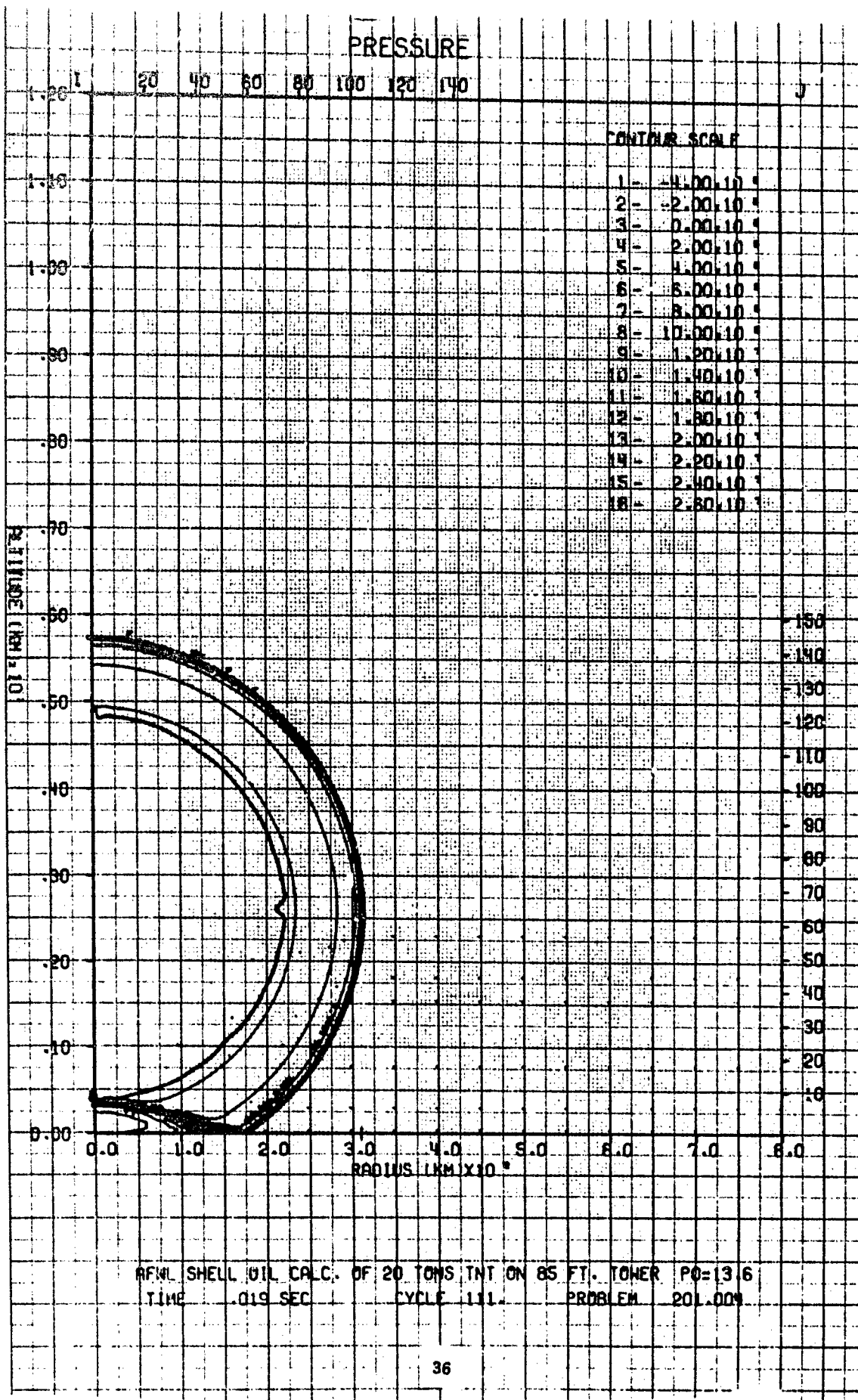
The numbers along the top of each plot represent the horizontal index of each cell of the mesh used in the calculation. The numbers along the right edge of the plot refer to vertical indices. The number associated with each contour line represents a value for that line appearing in the upper right hand corner of each contour plot. The velocity vector scale is similarly given in the upper right hand corner of each velocity vector plot.

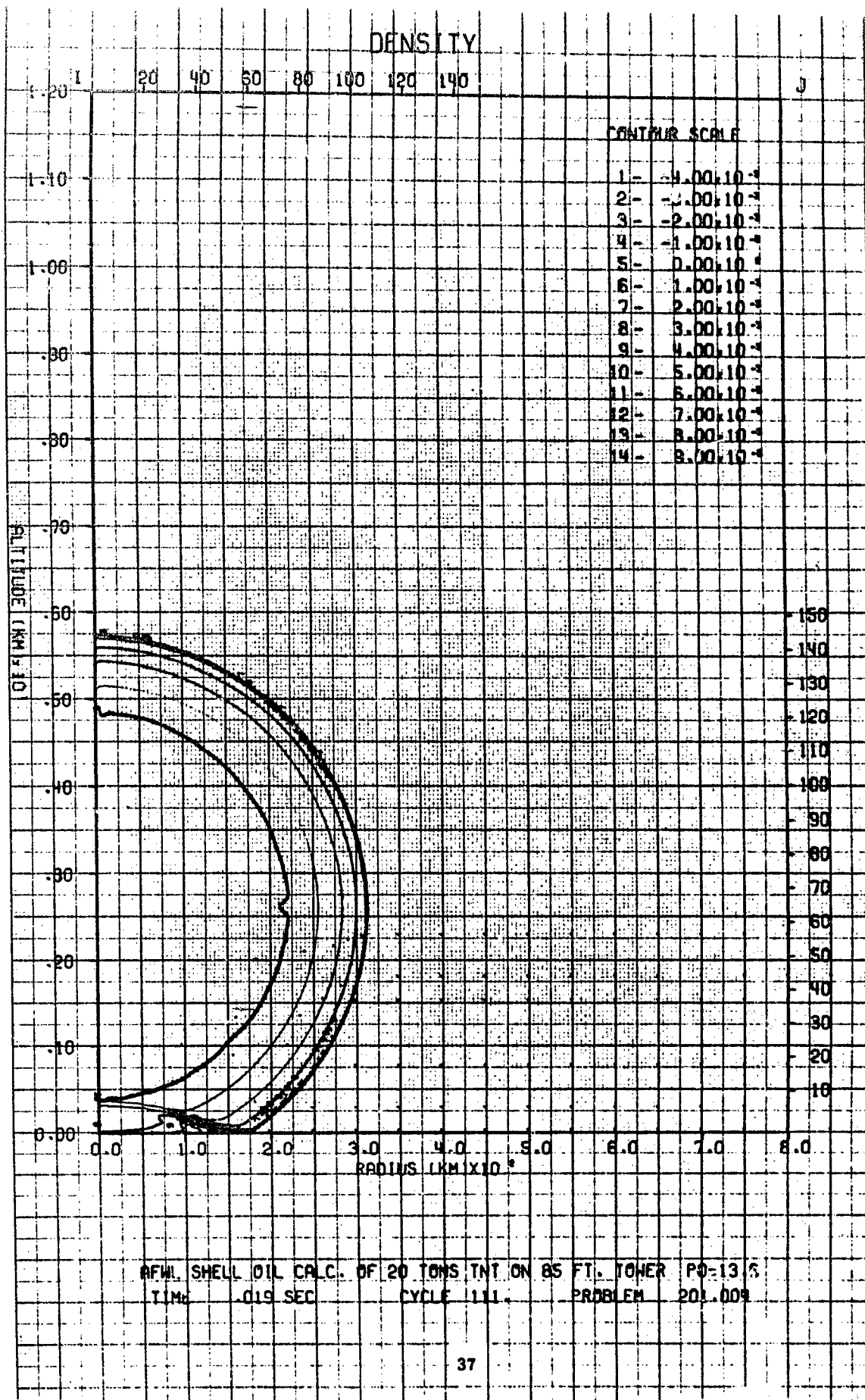
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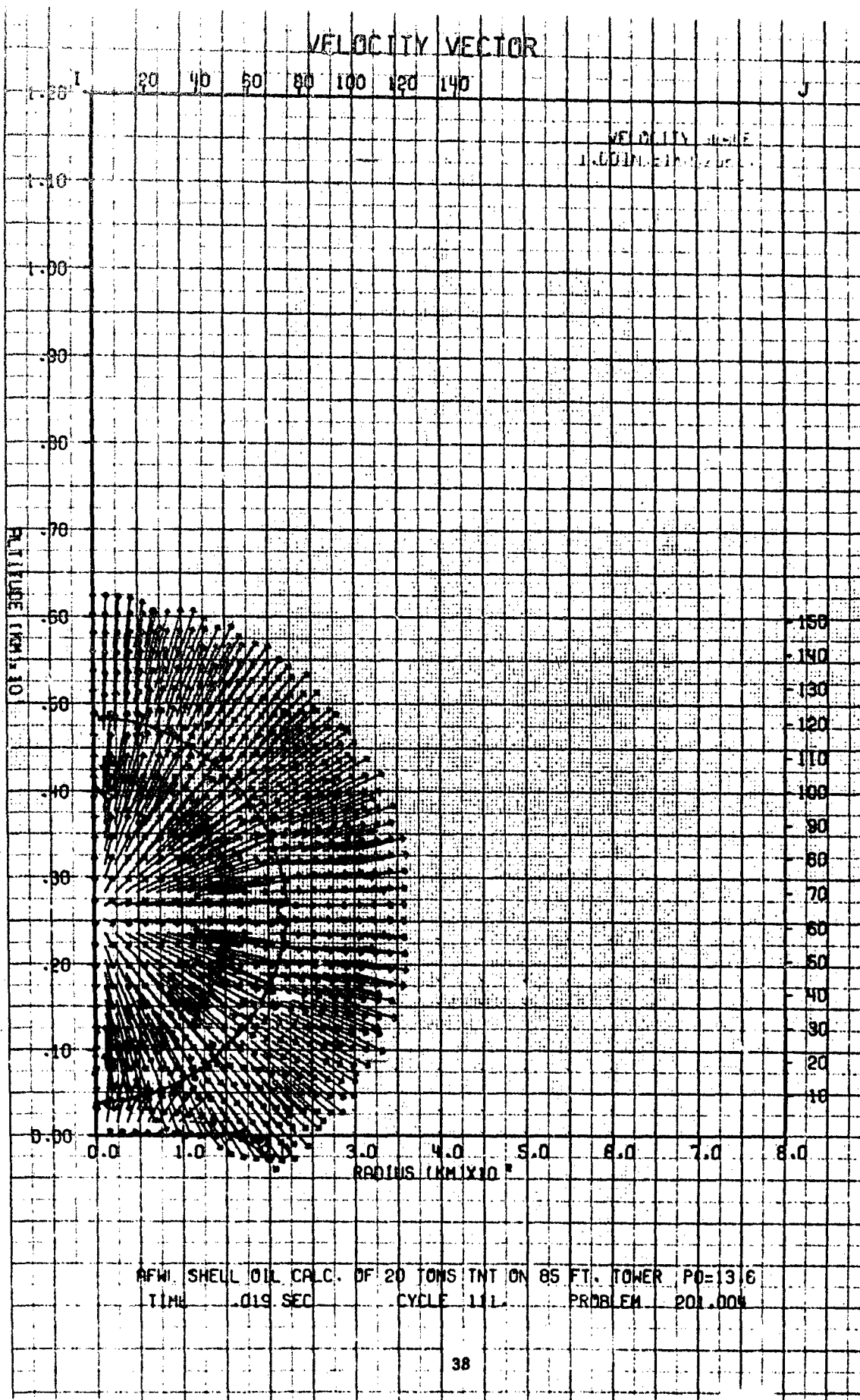


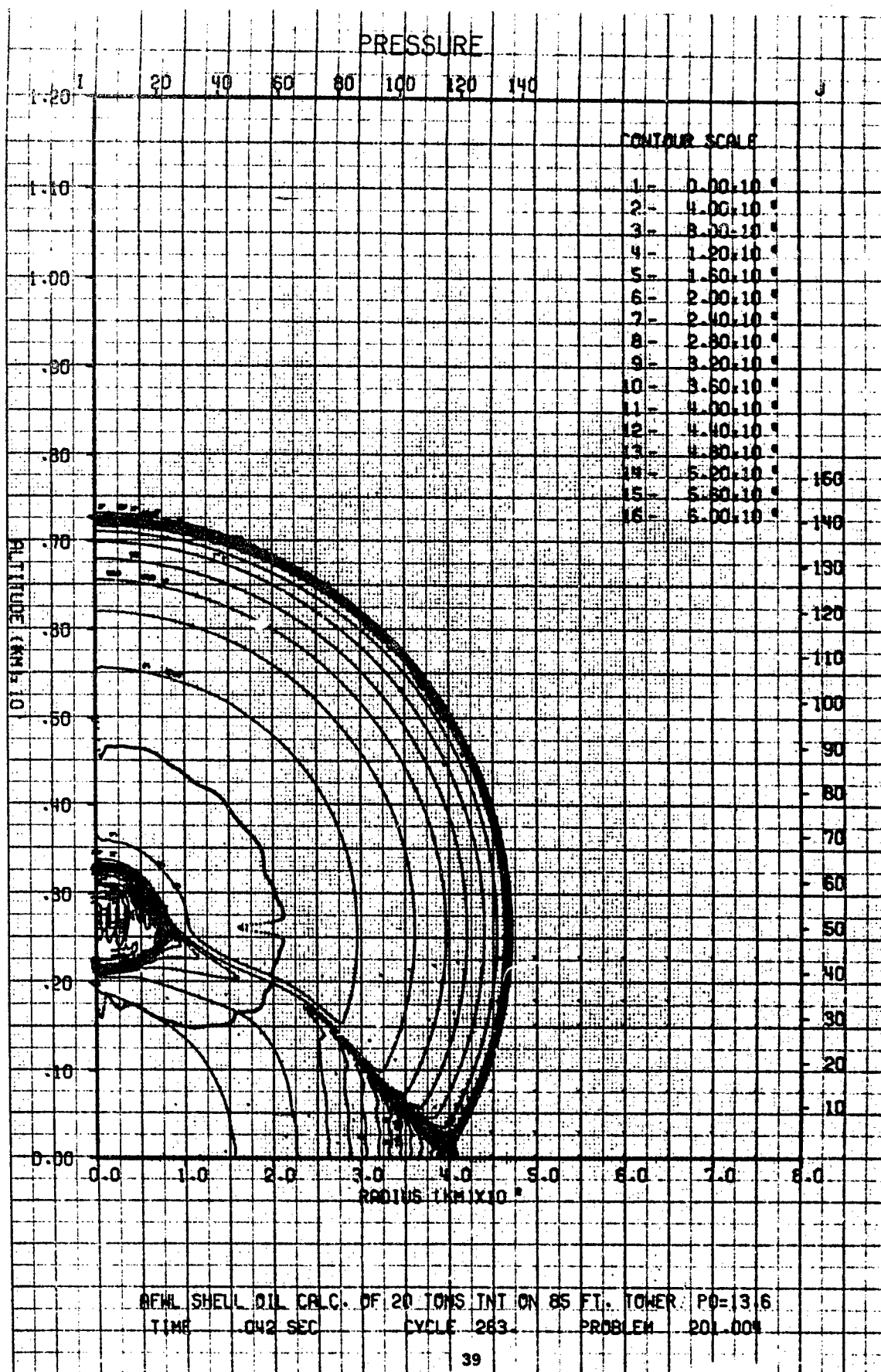


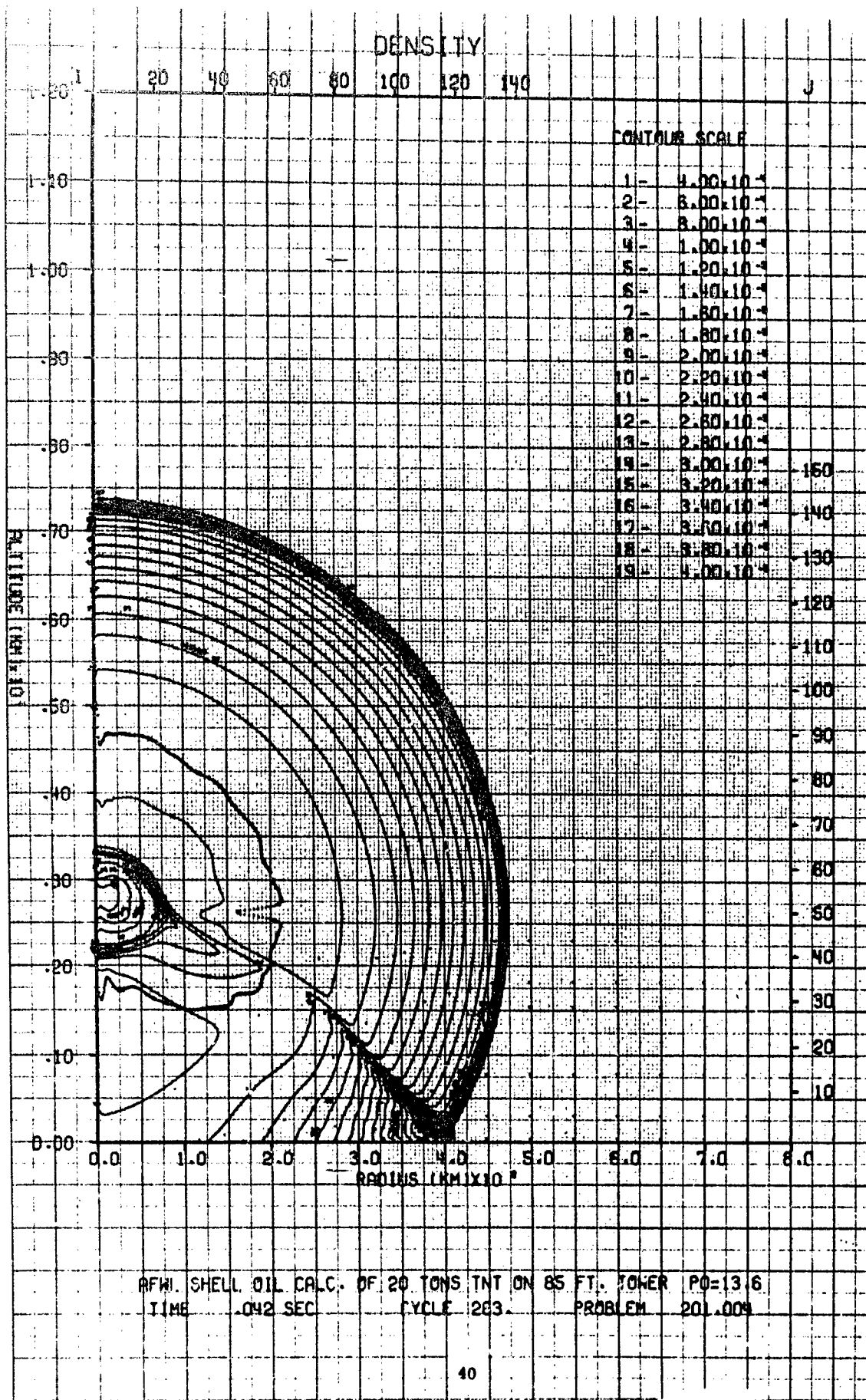


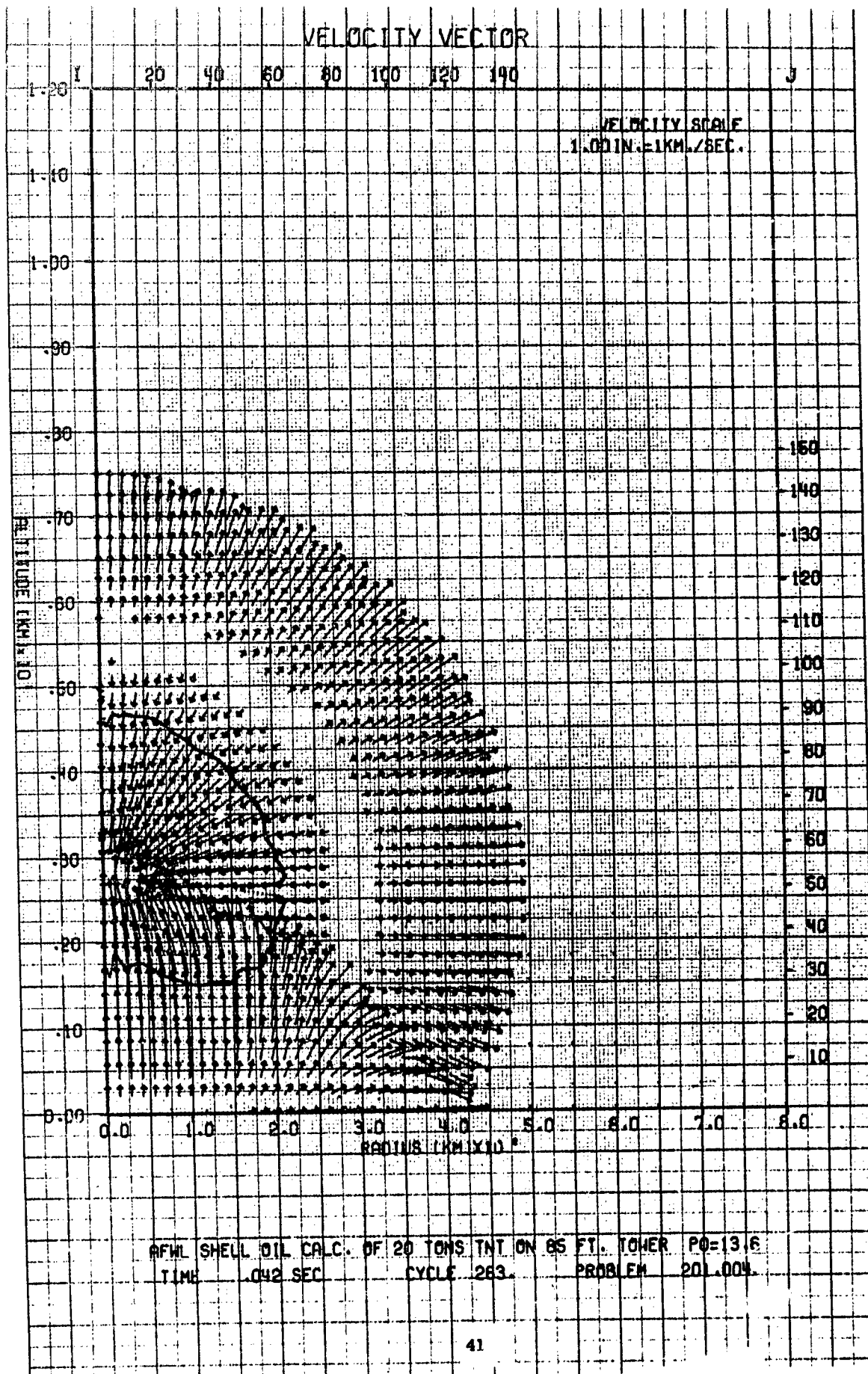


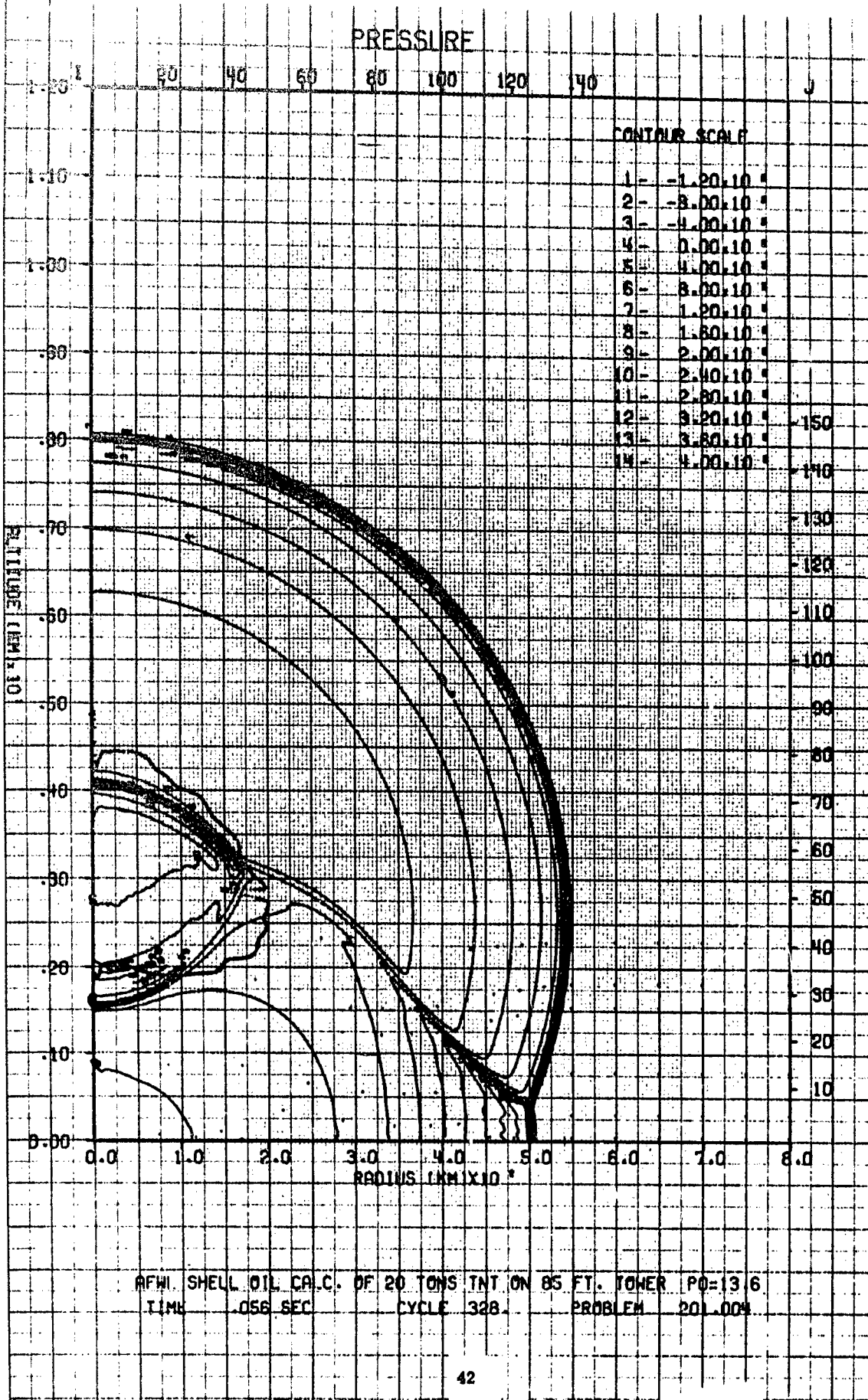


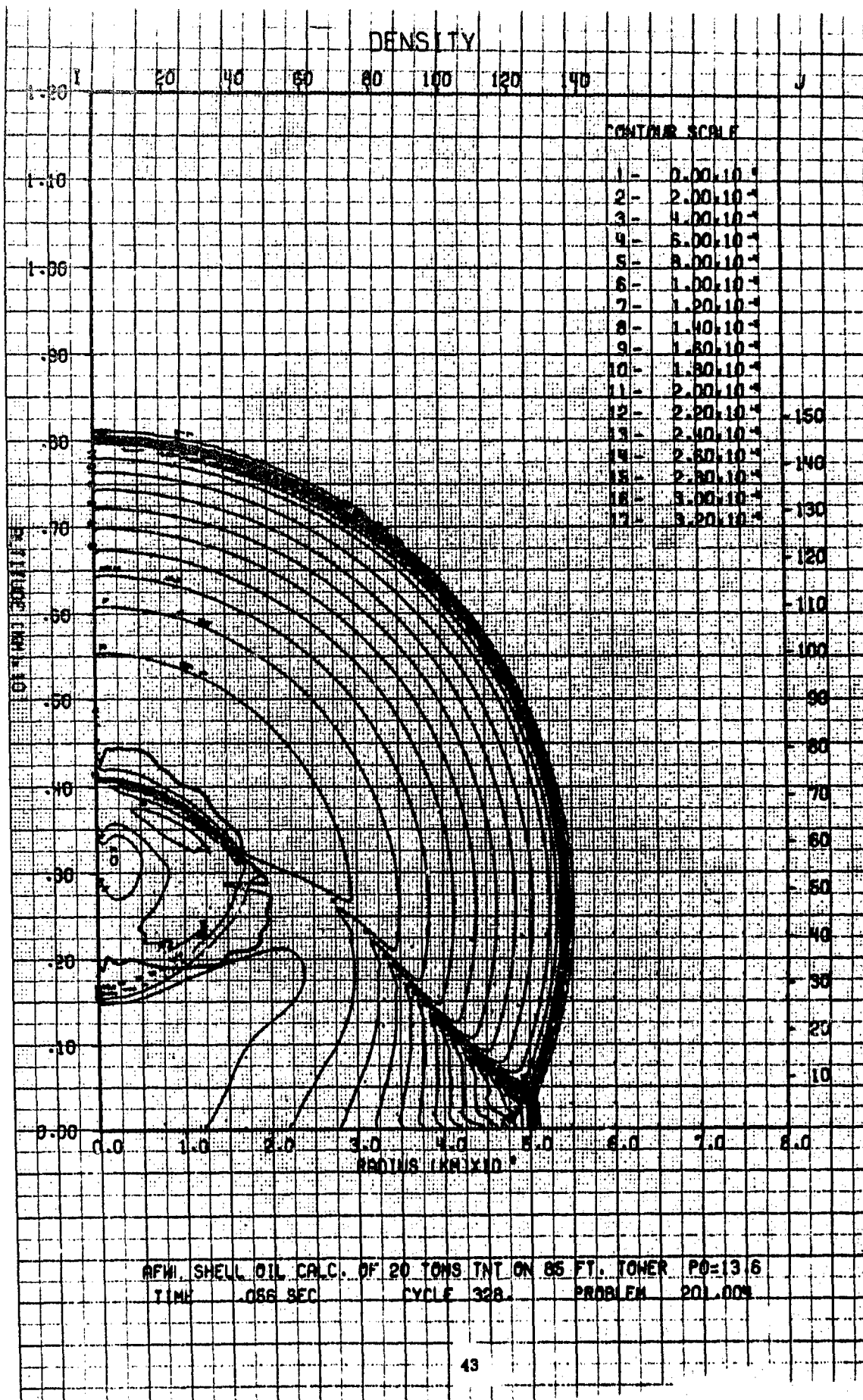


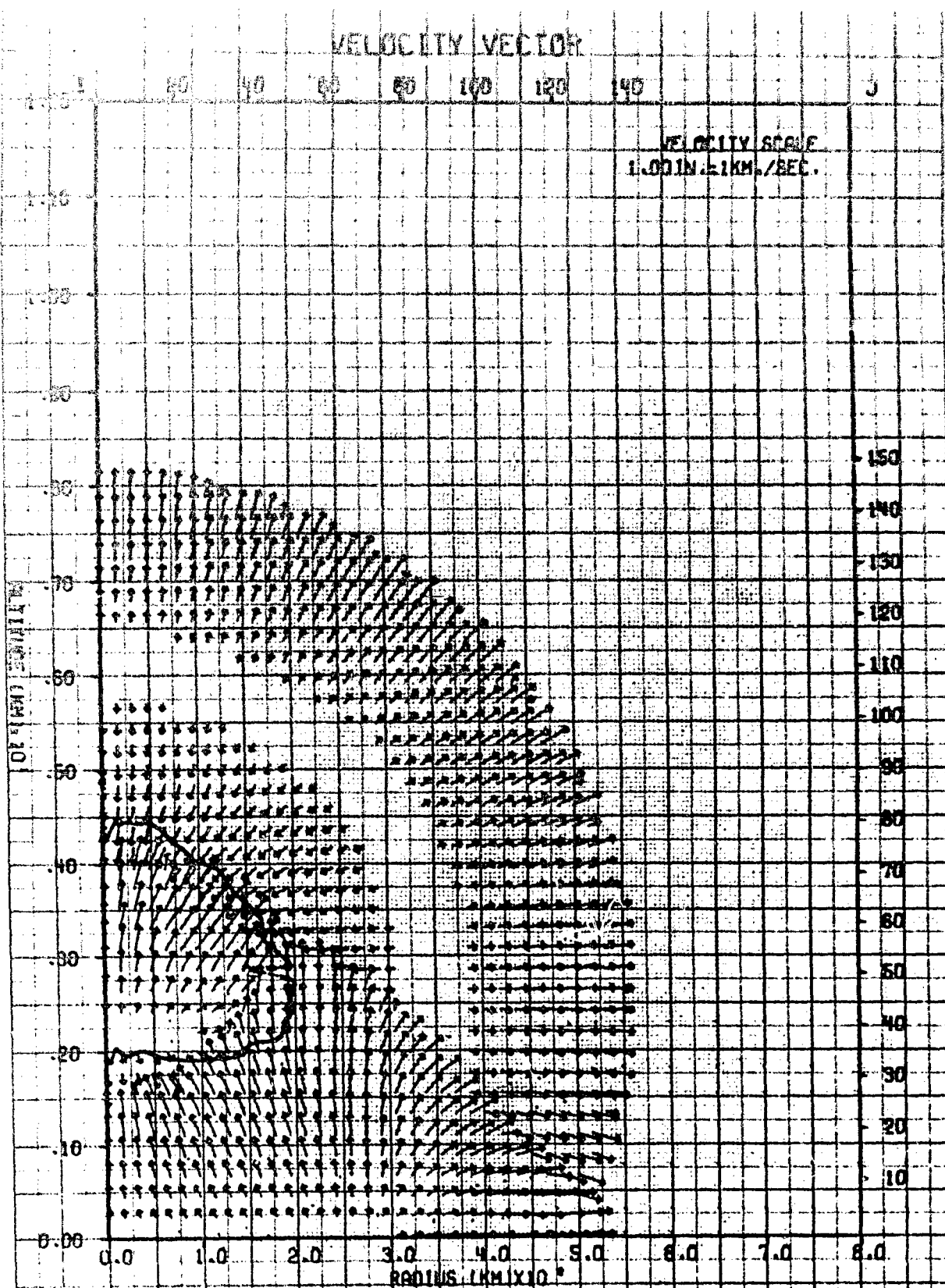




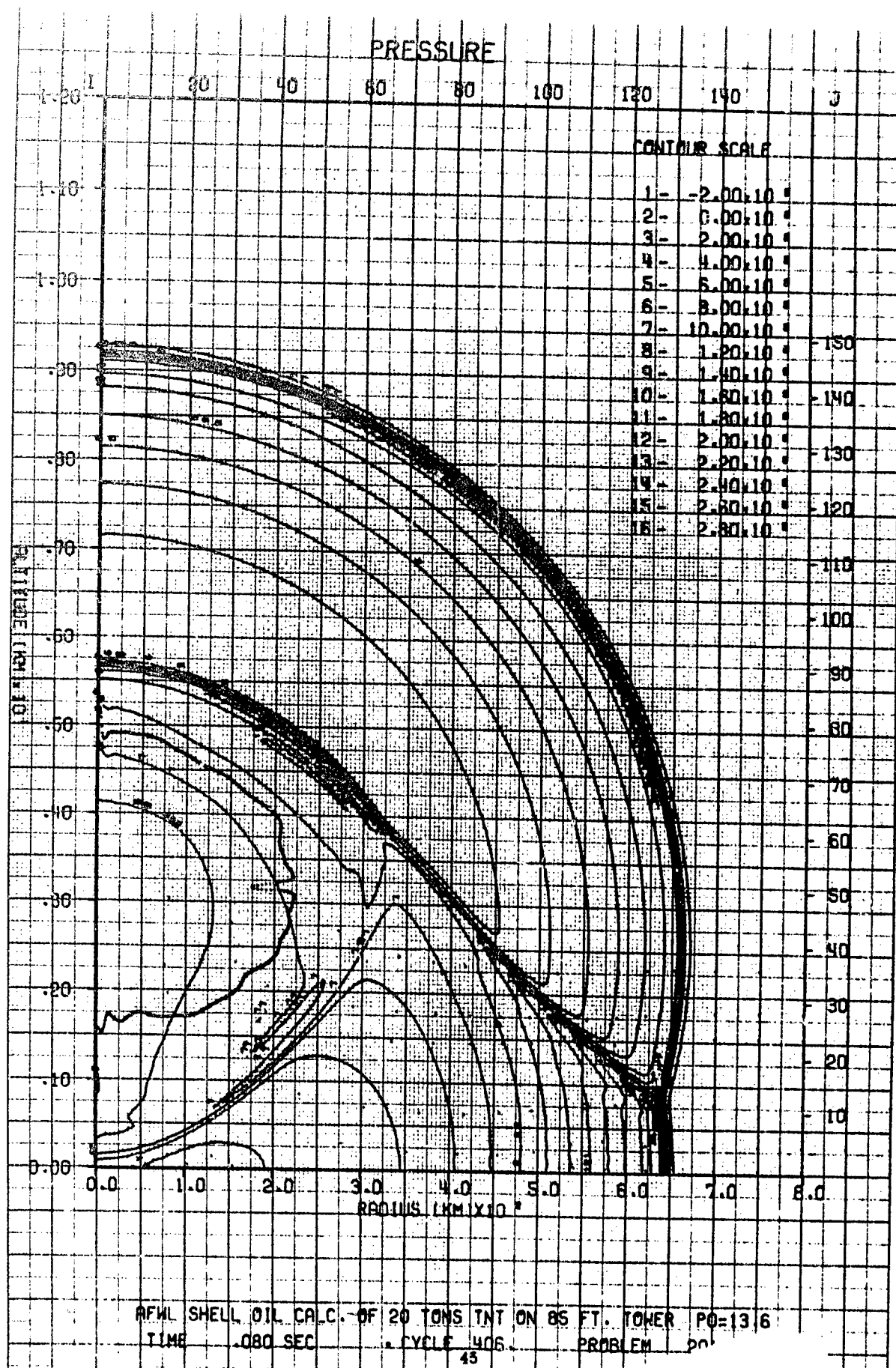


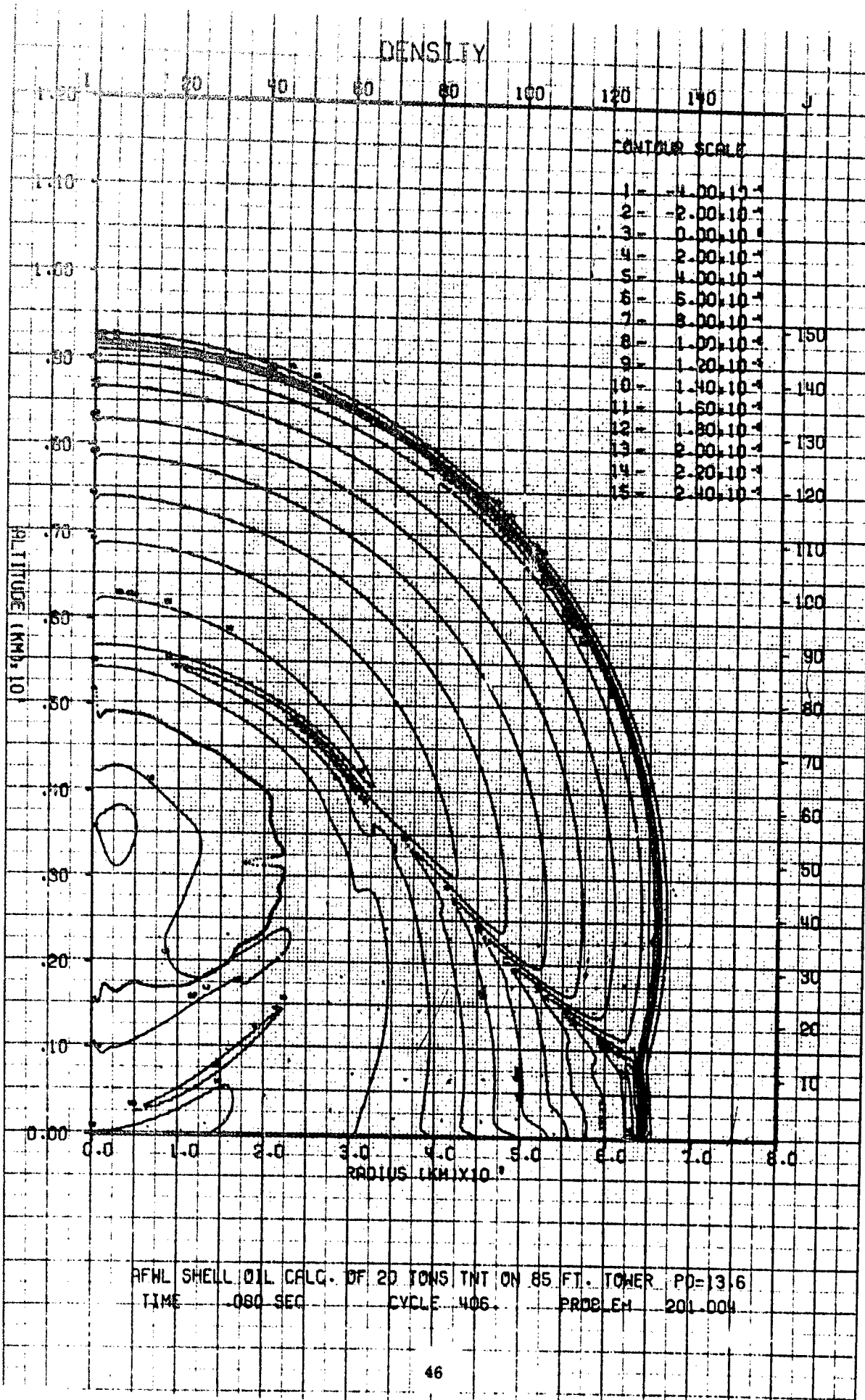


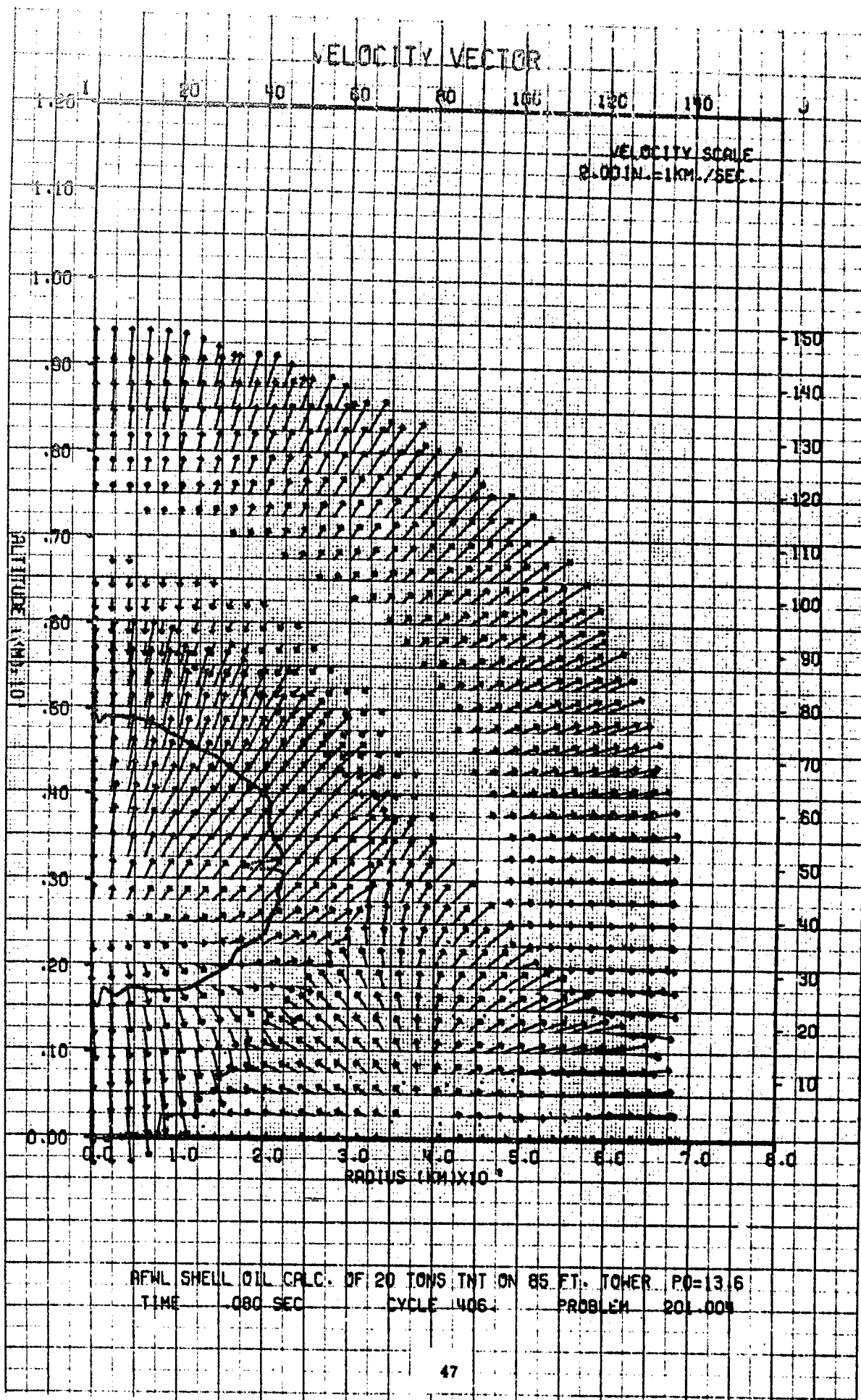


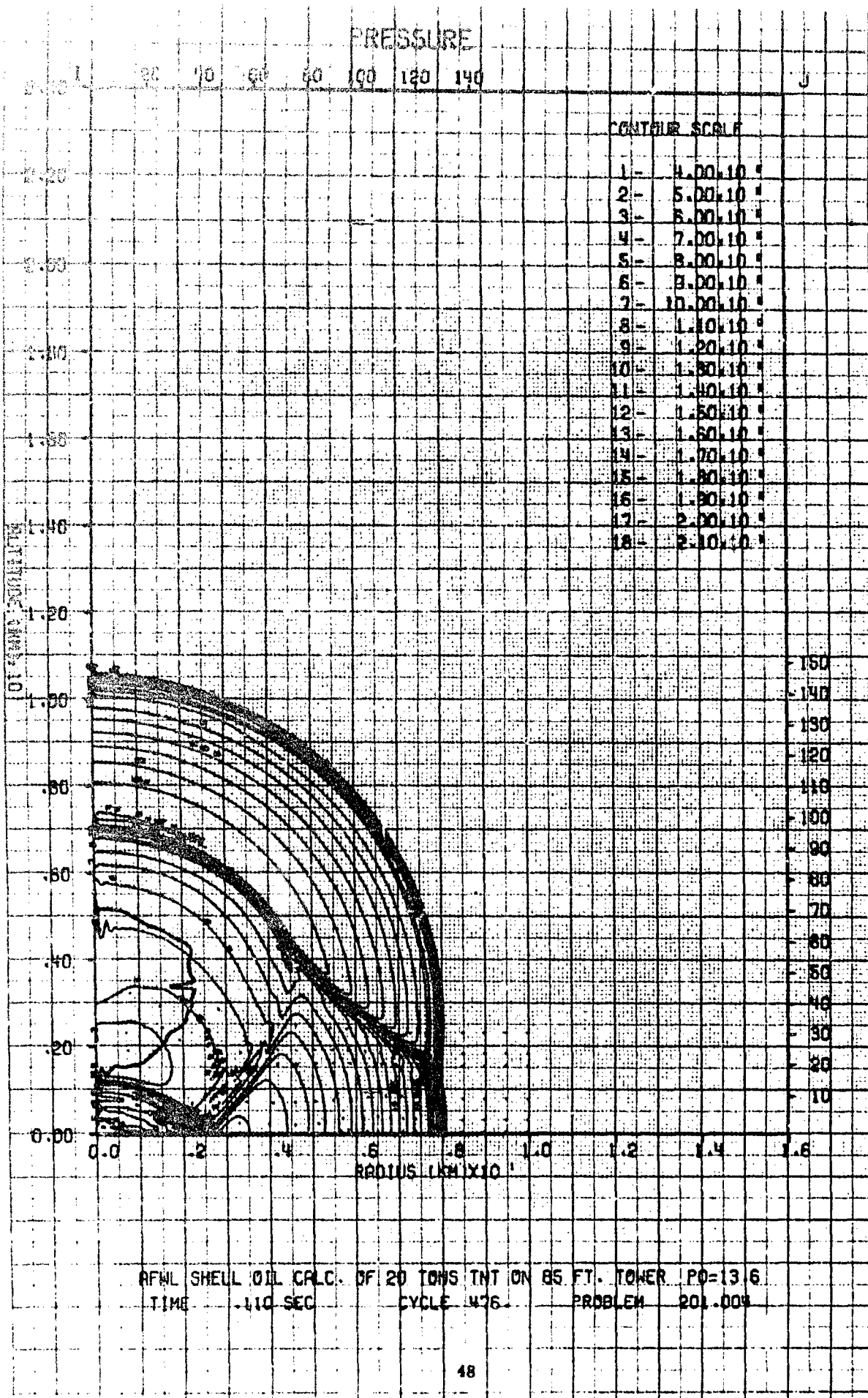


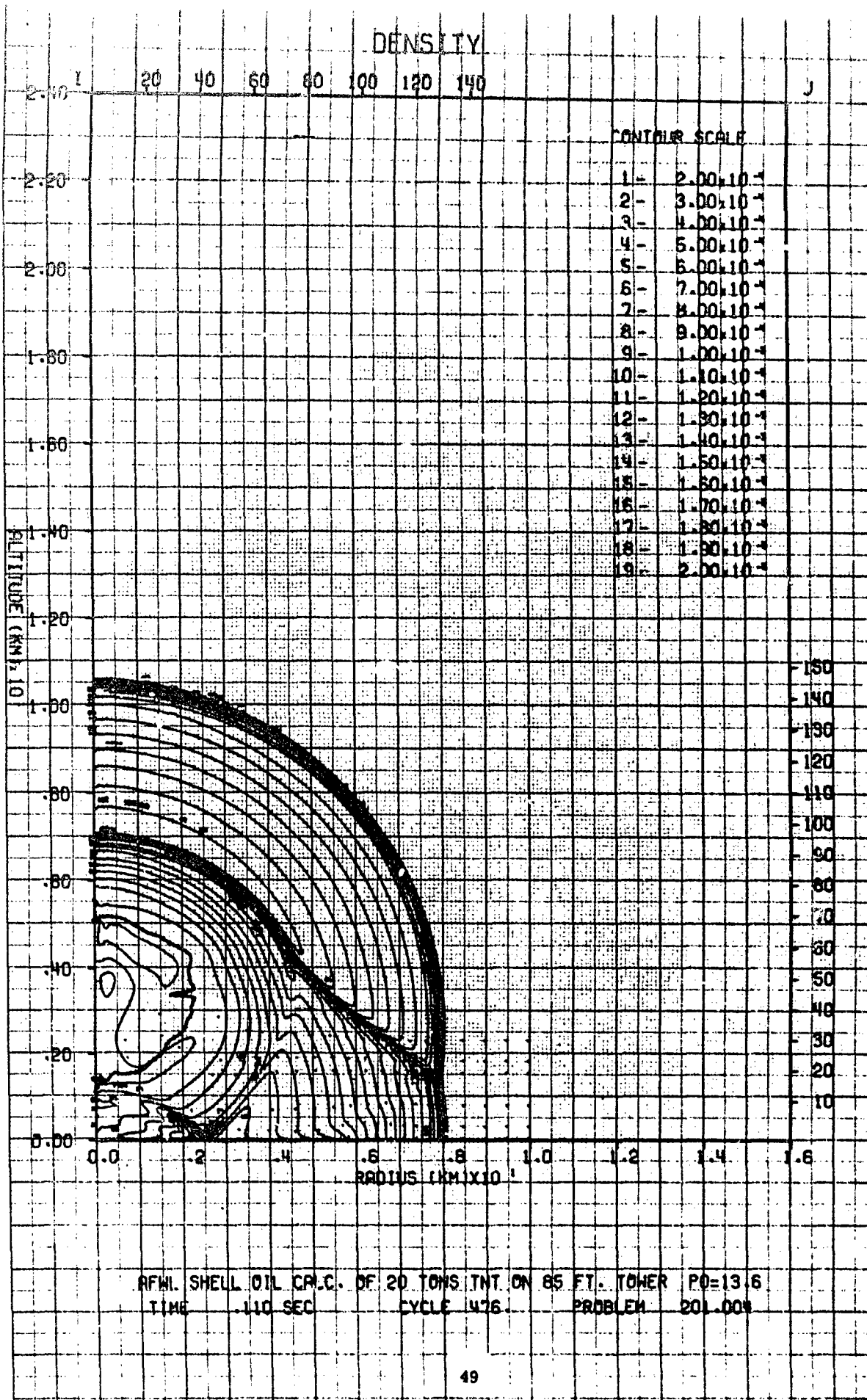
AFWL SHELL OIL CALC. OF 20 TONS TNT ON 85 FT. TOWER P0=13.6
 TIME .056 SEC CYCLE 328. PROBLEM 201.009

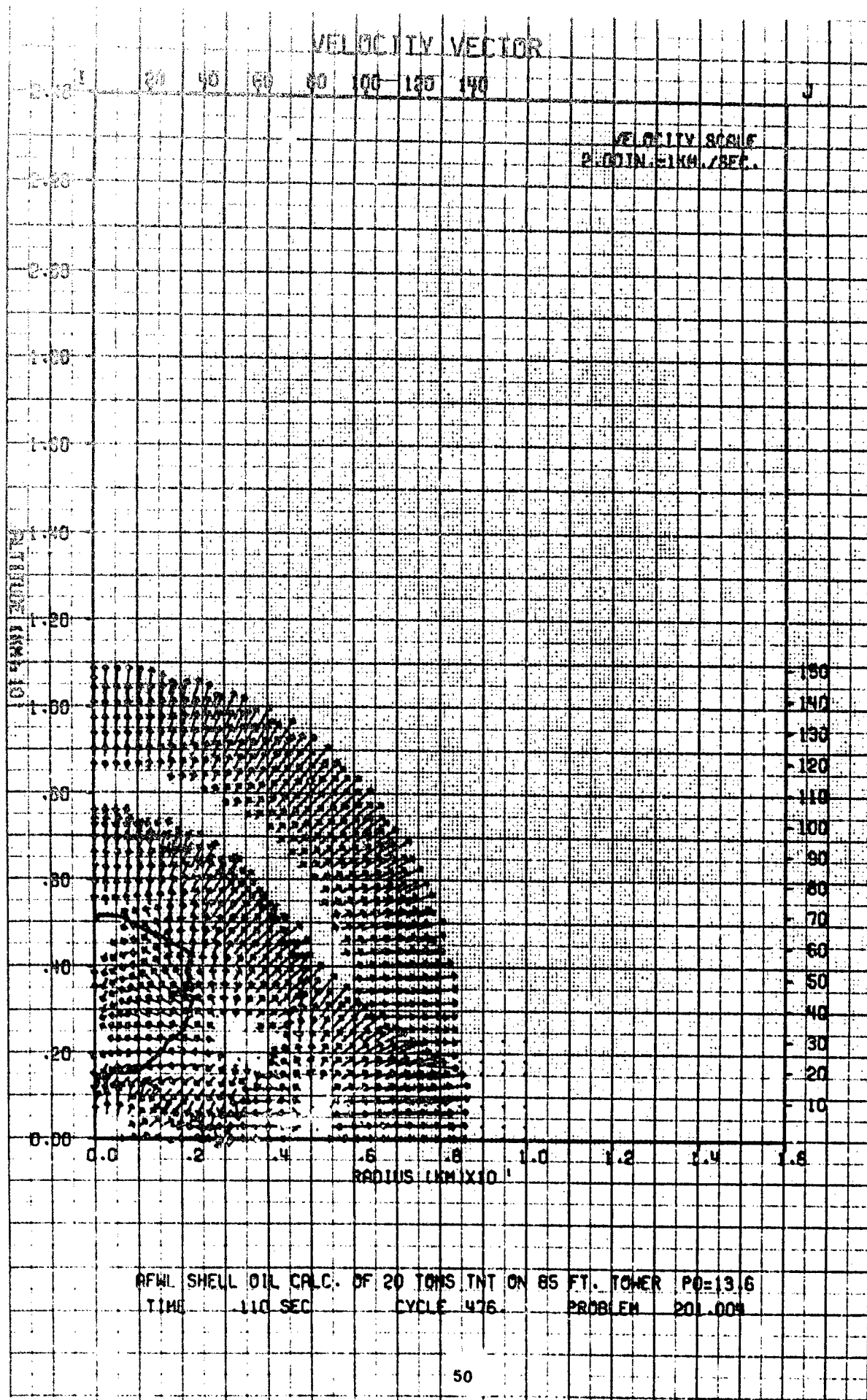


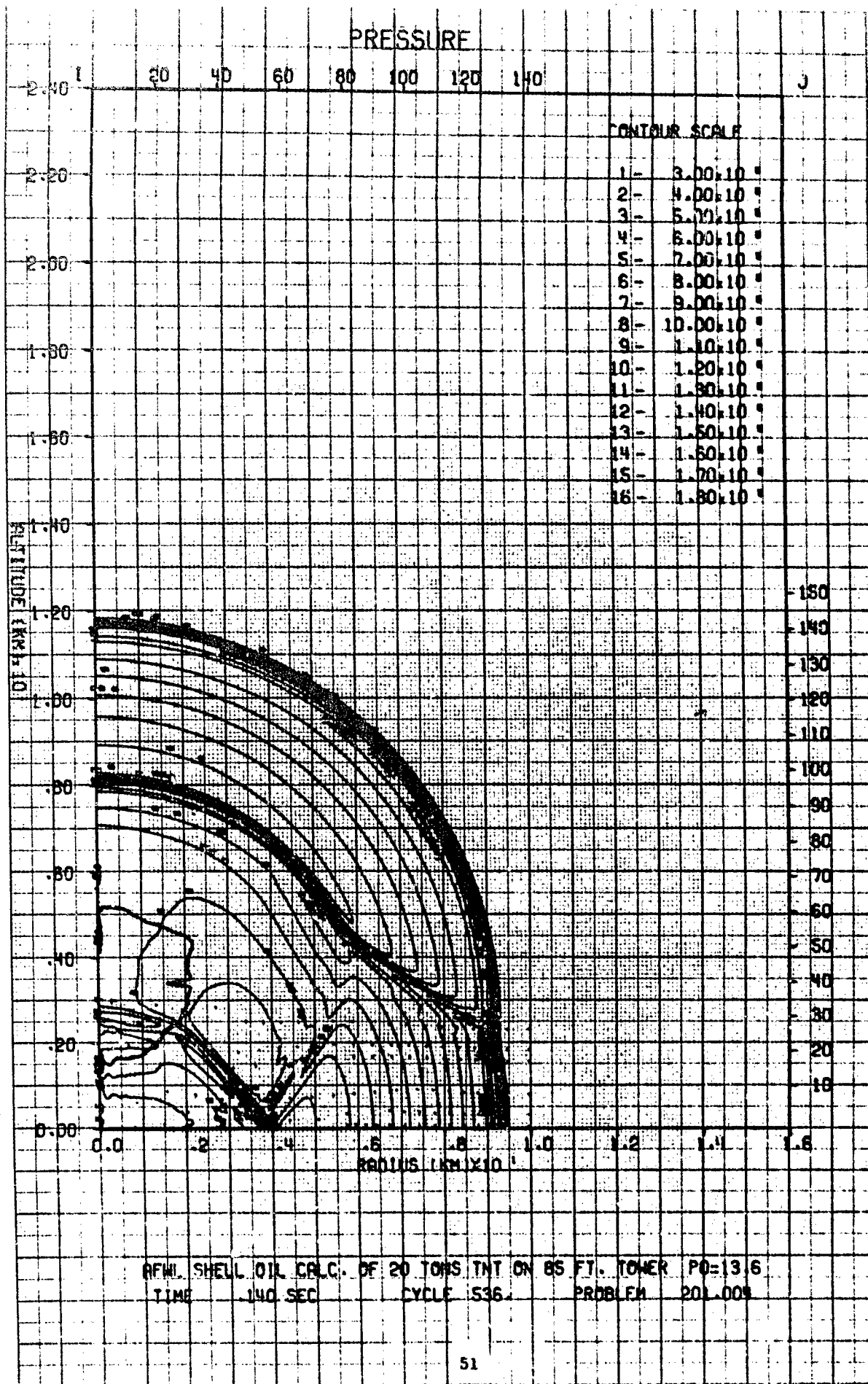


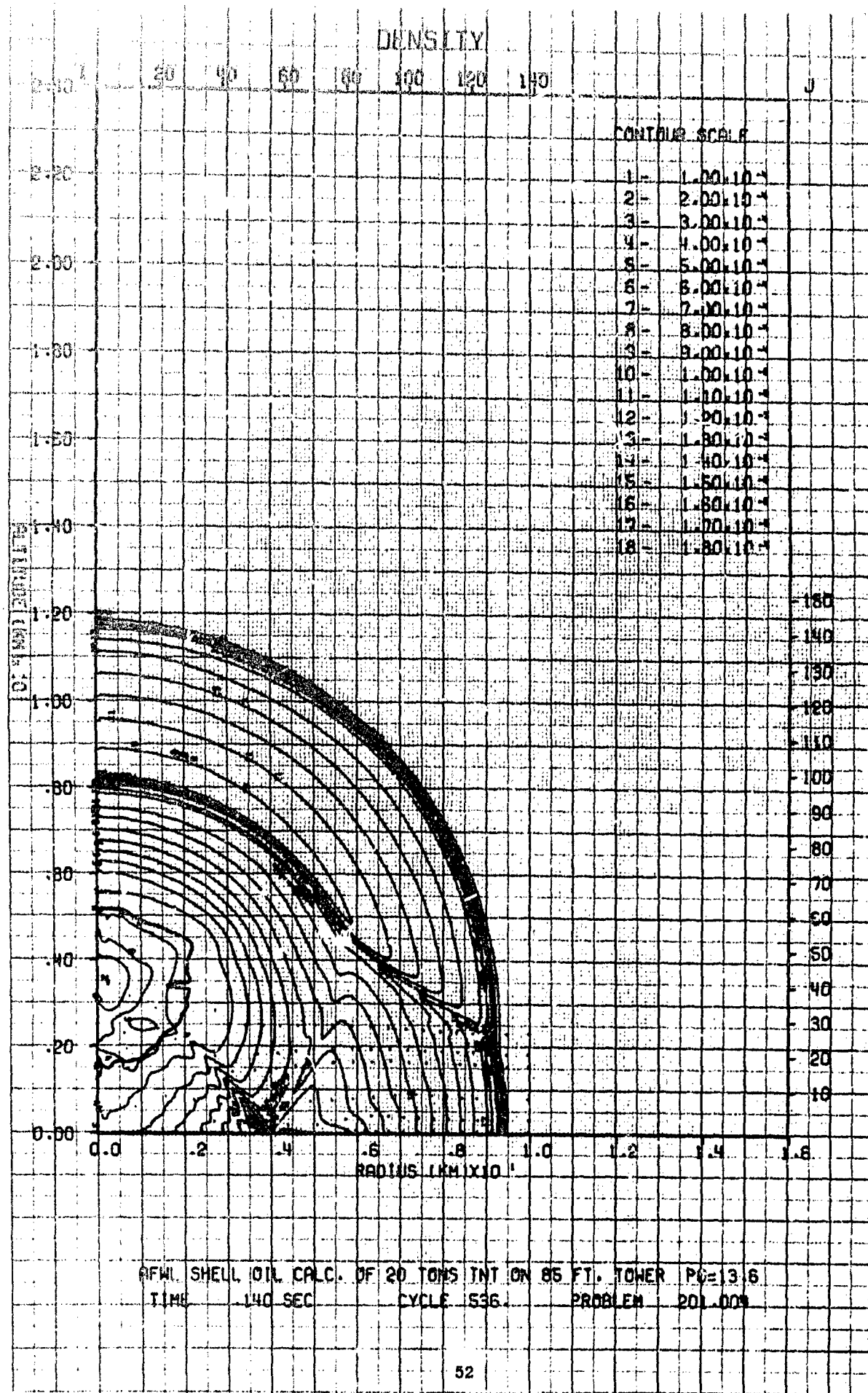


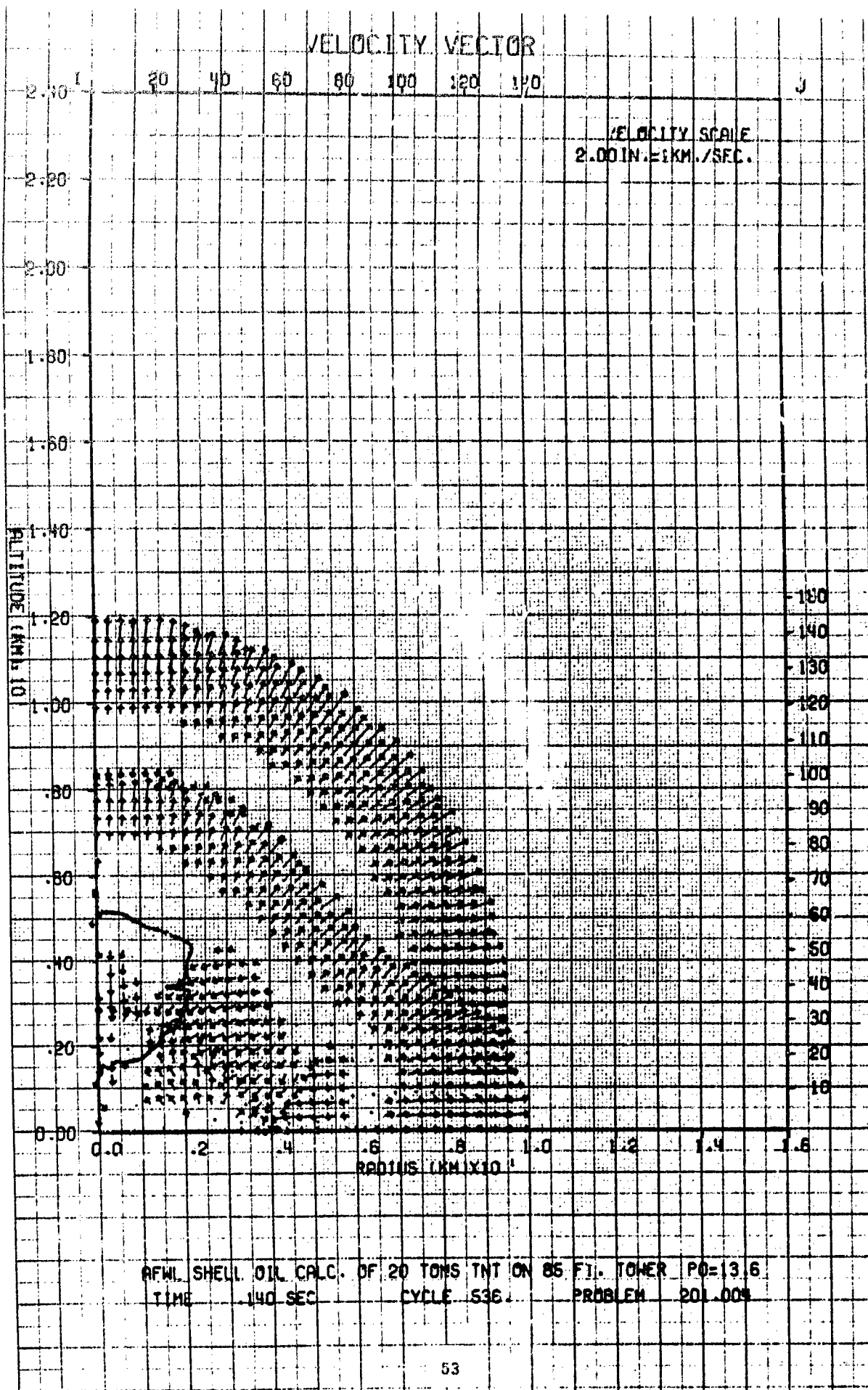


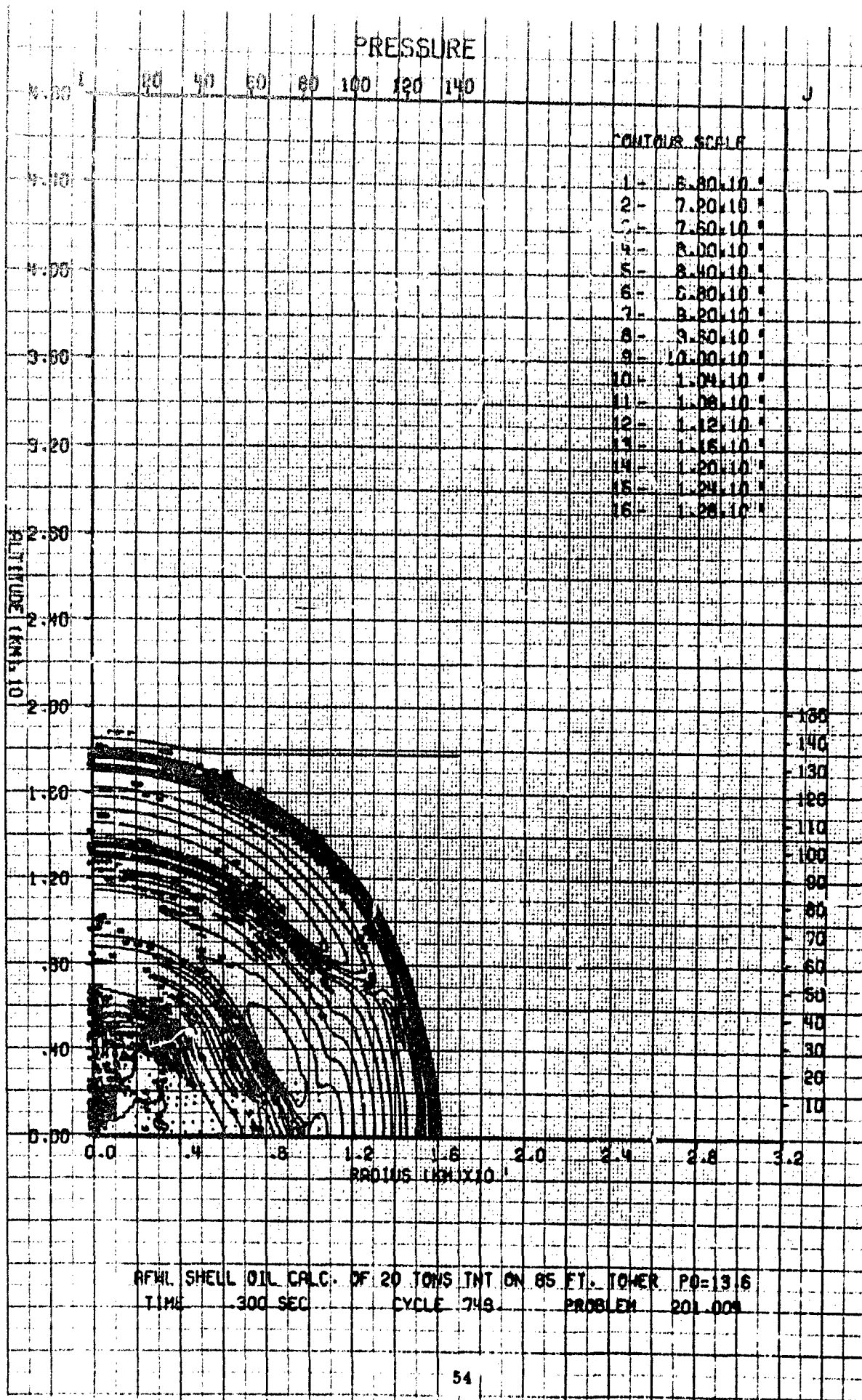


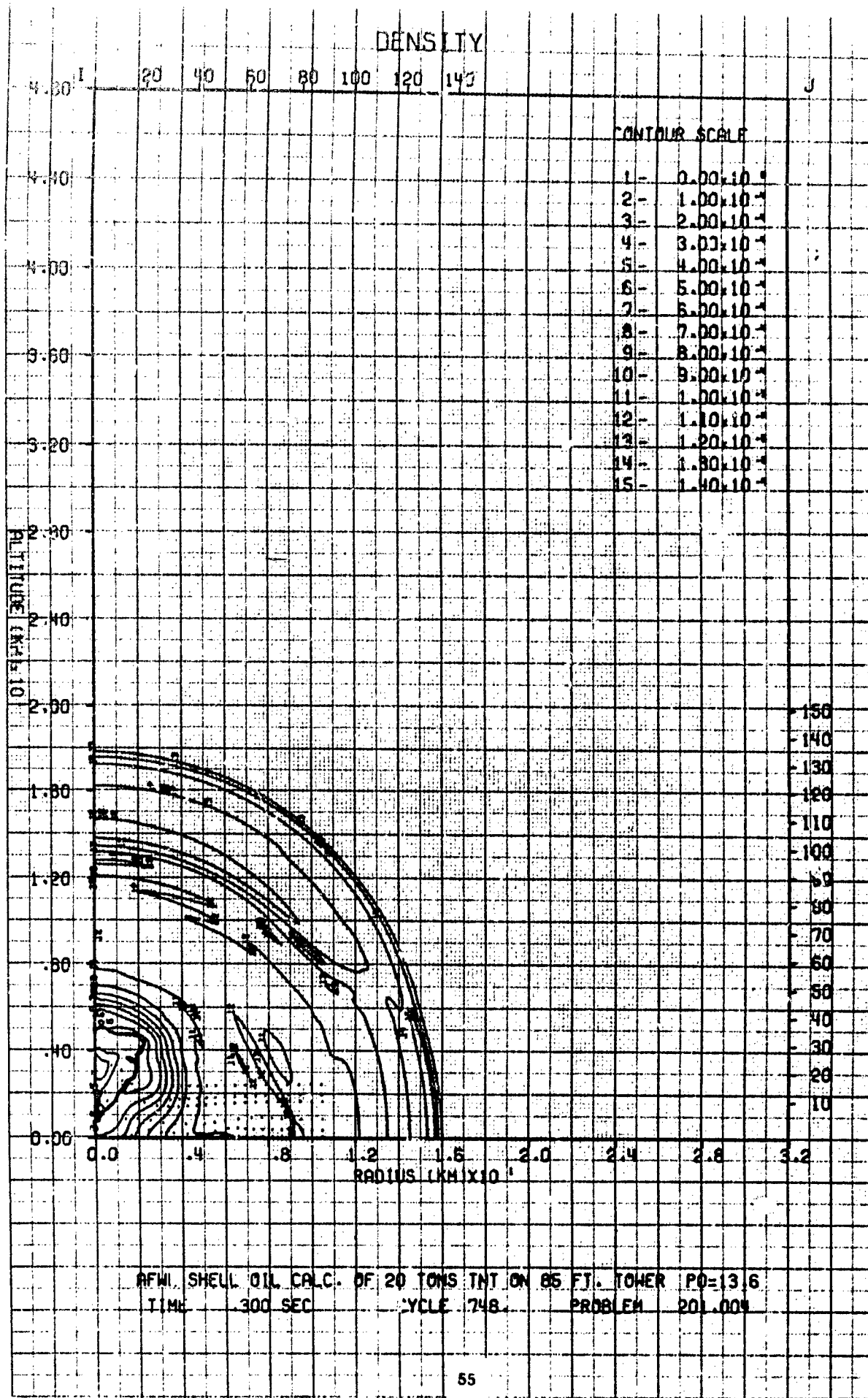


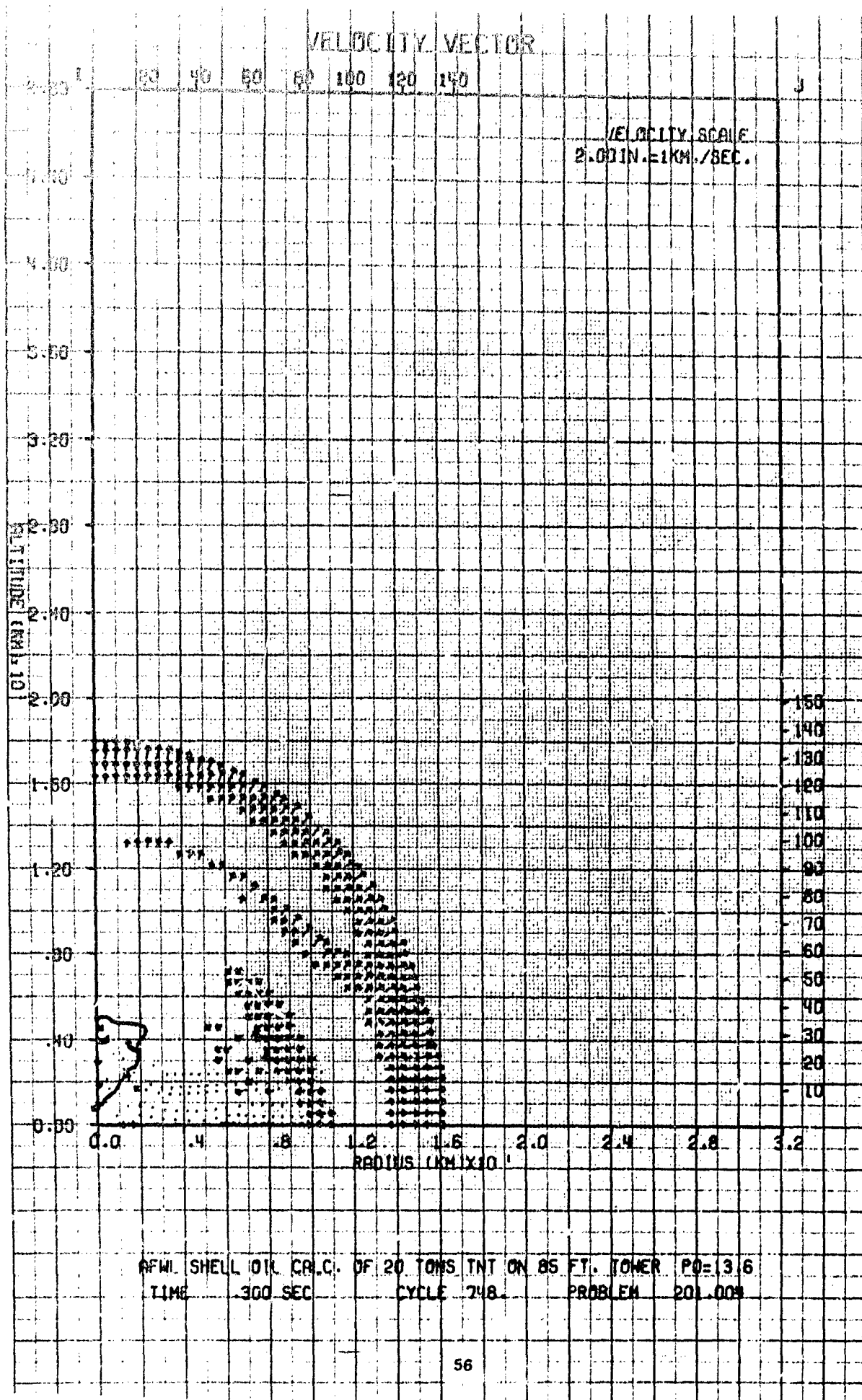












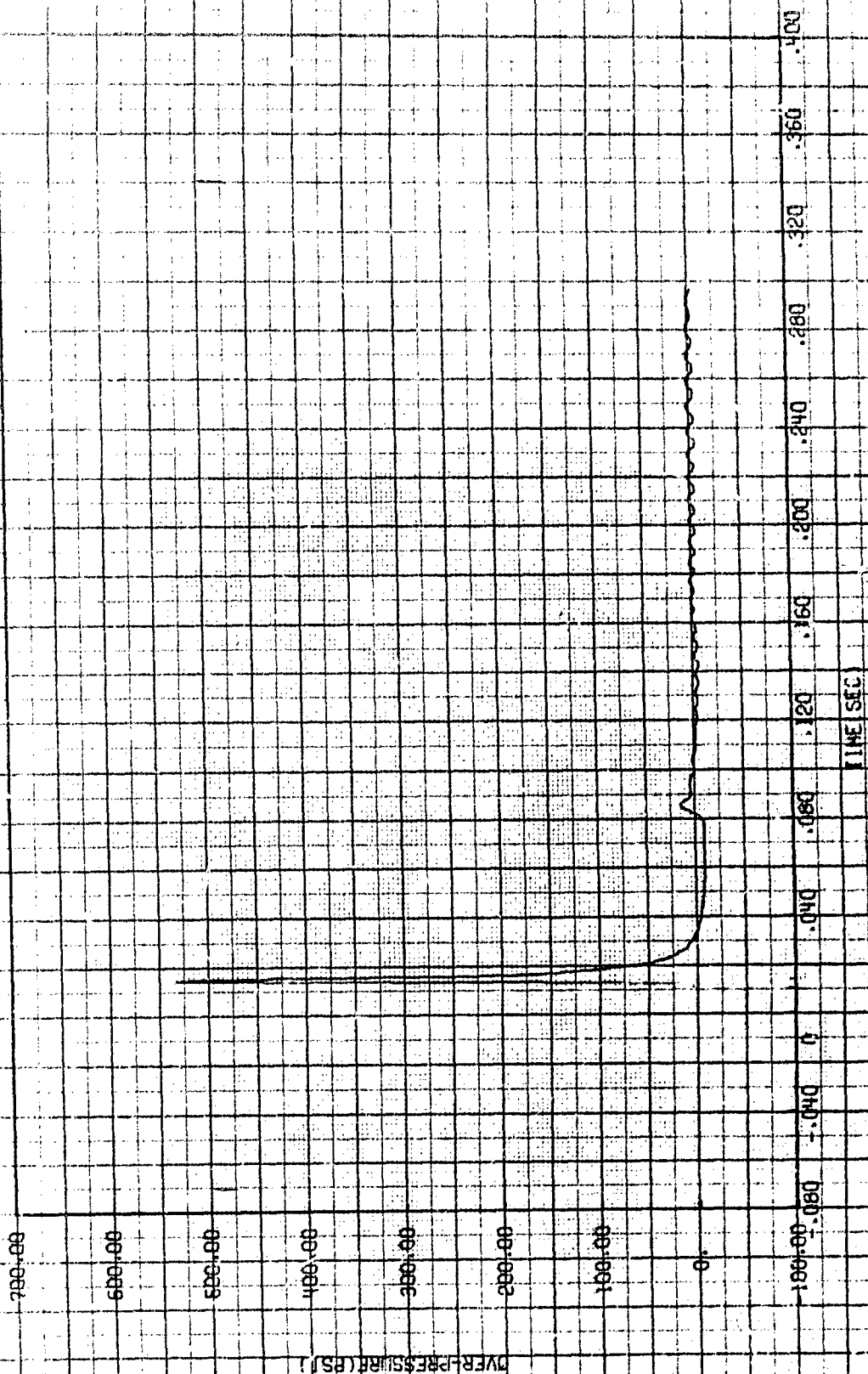
SHELL Tracings

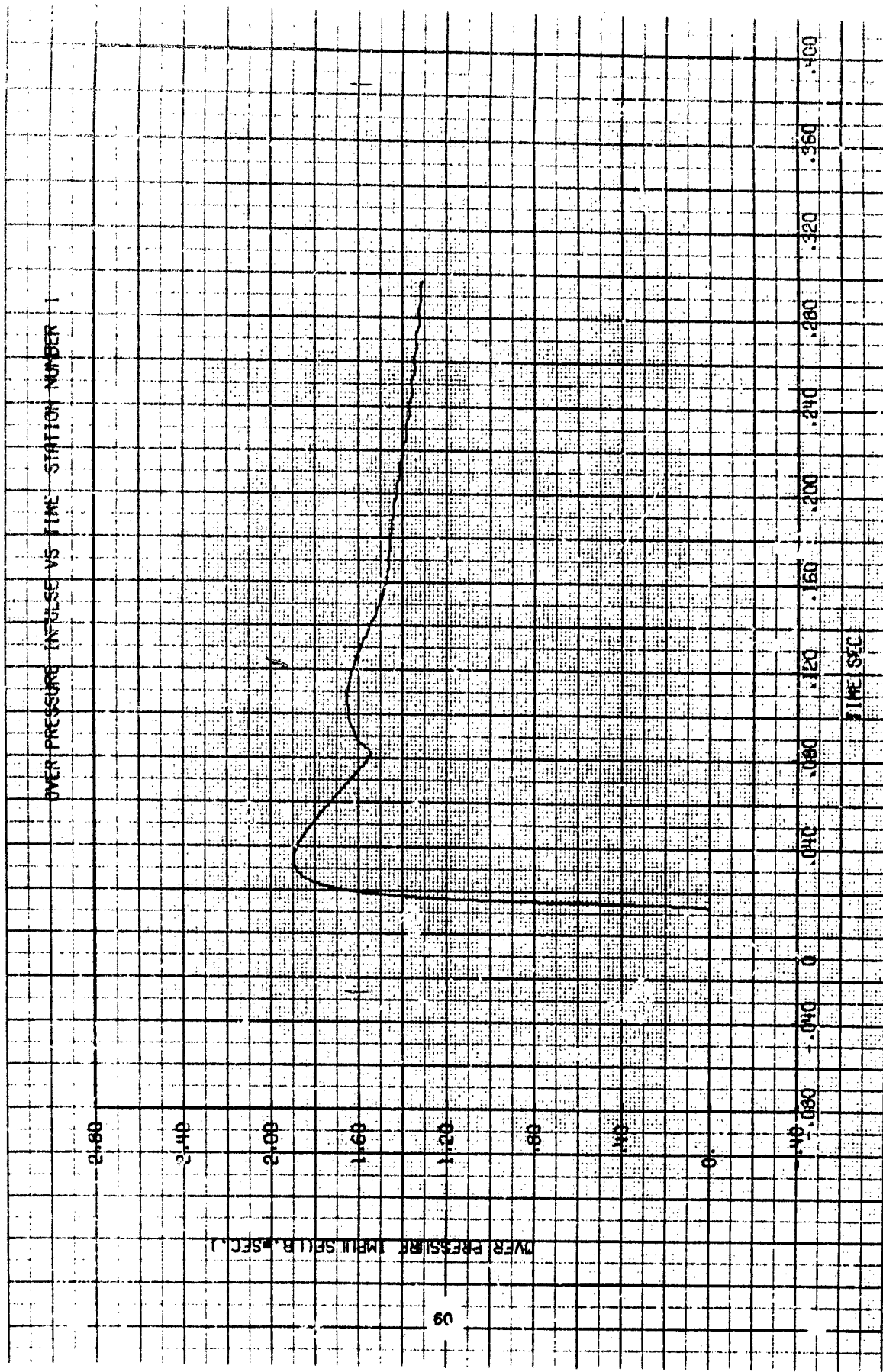
This part contains the tracings recorded at each test station of overpressure, dynamic pressure overpressure impulse, dynamic pressure impulse and velocity resulting from the TNT detonation. These are SHELL-OIL results.

Table I gives the location of each test station.

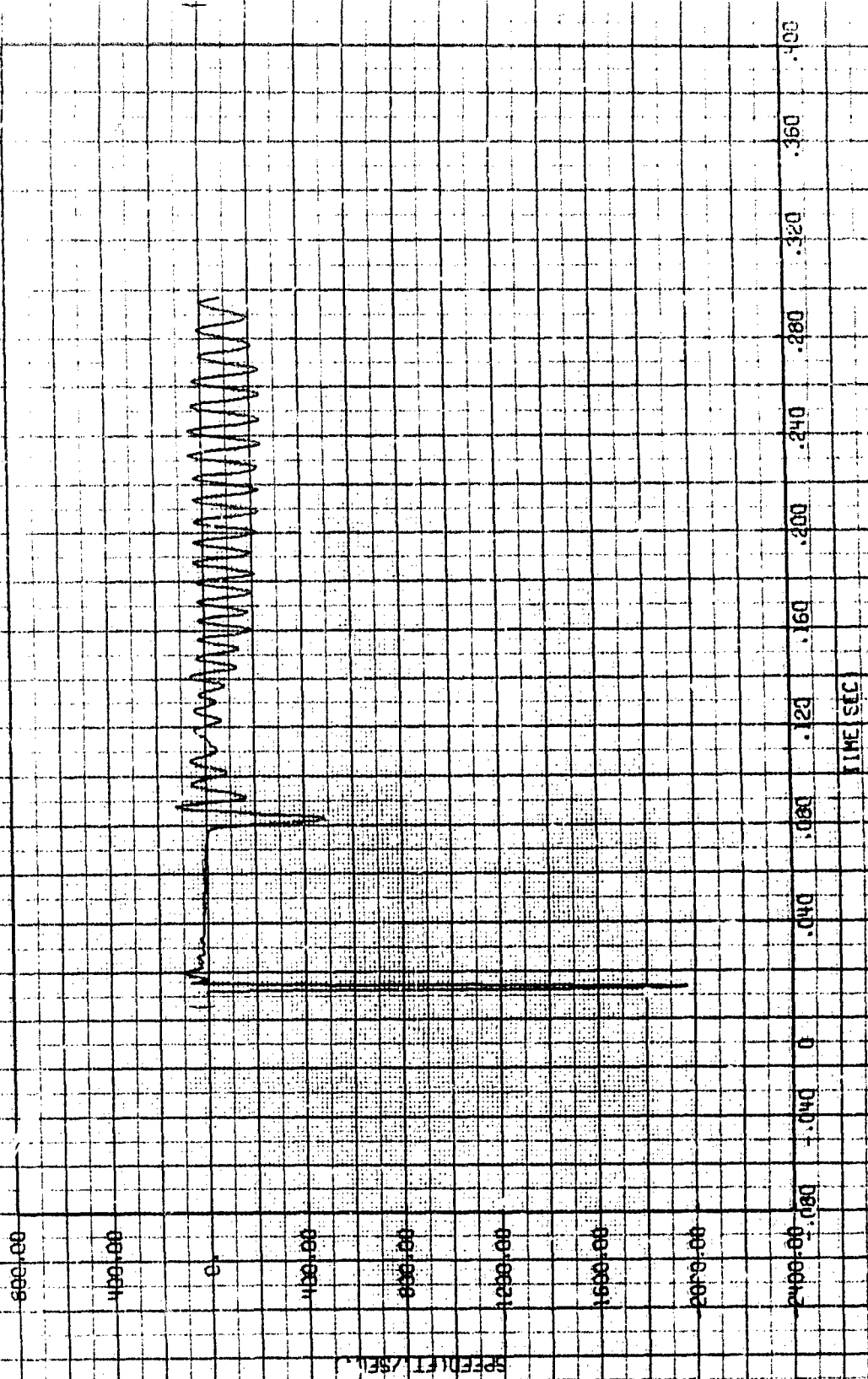
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OVER PRESSURE VS TIME STATION NUMBER 1

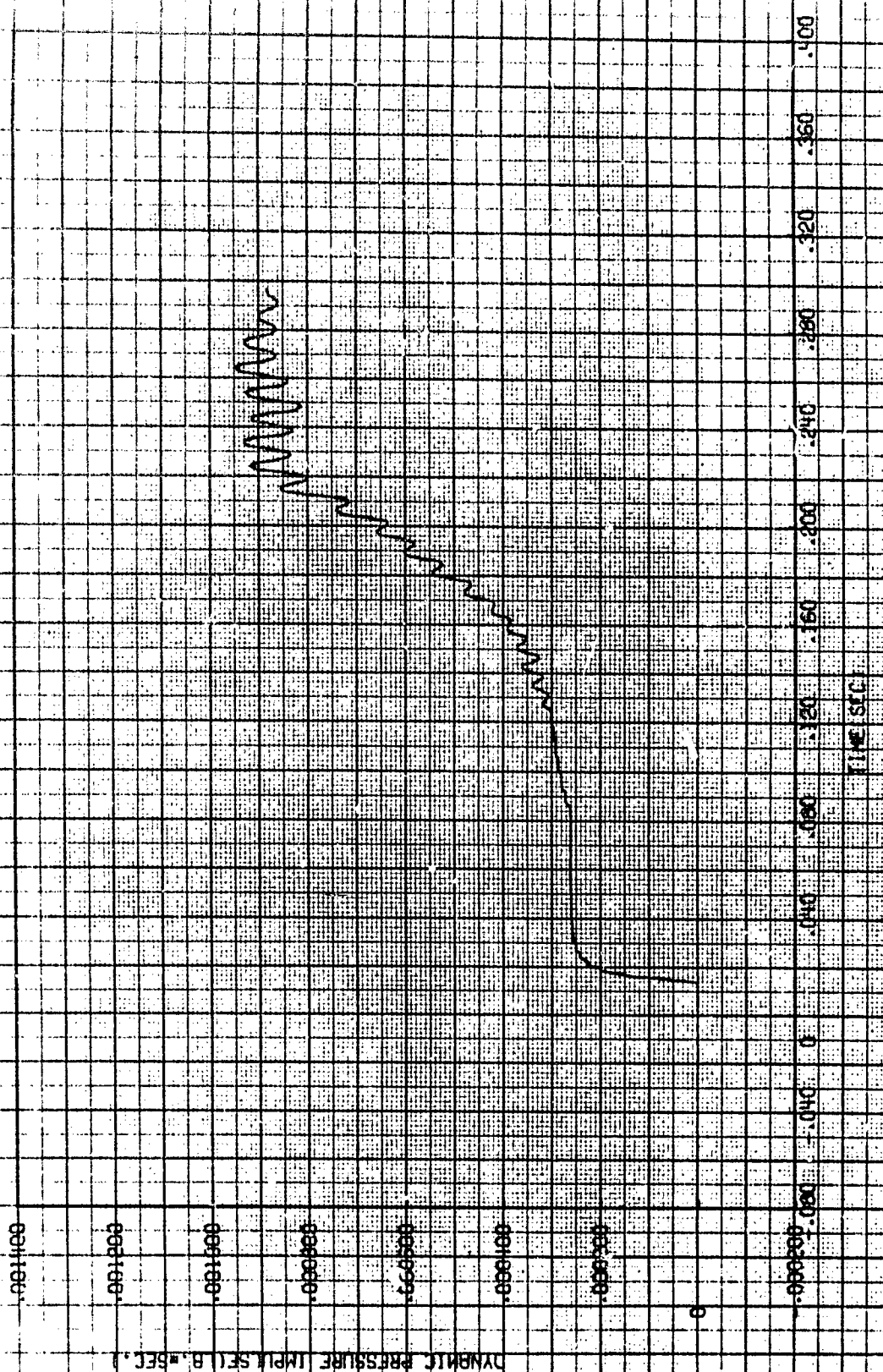


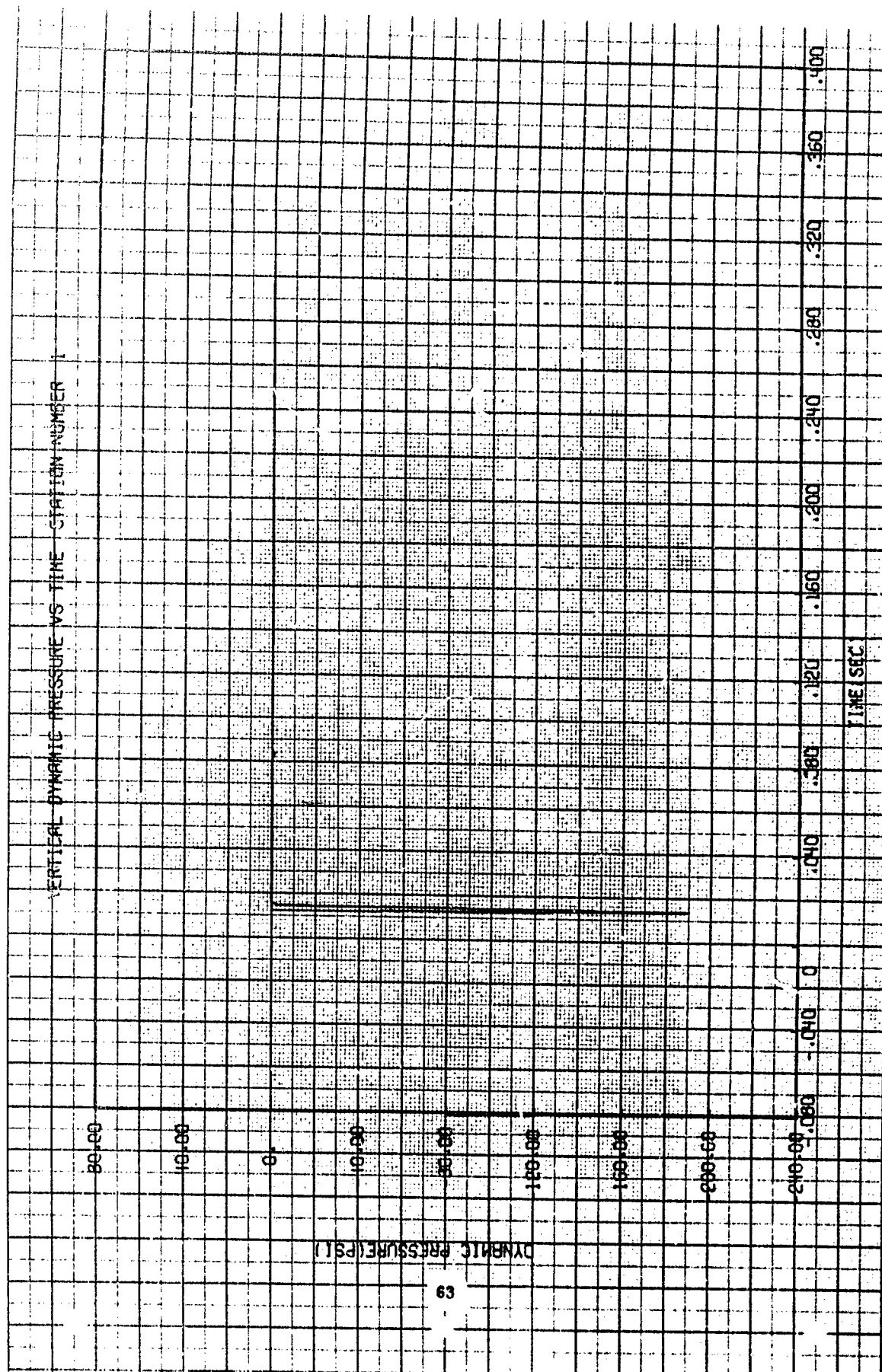


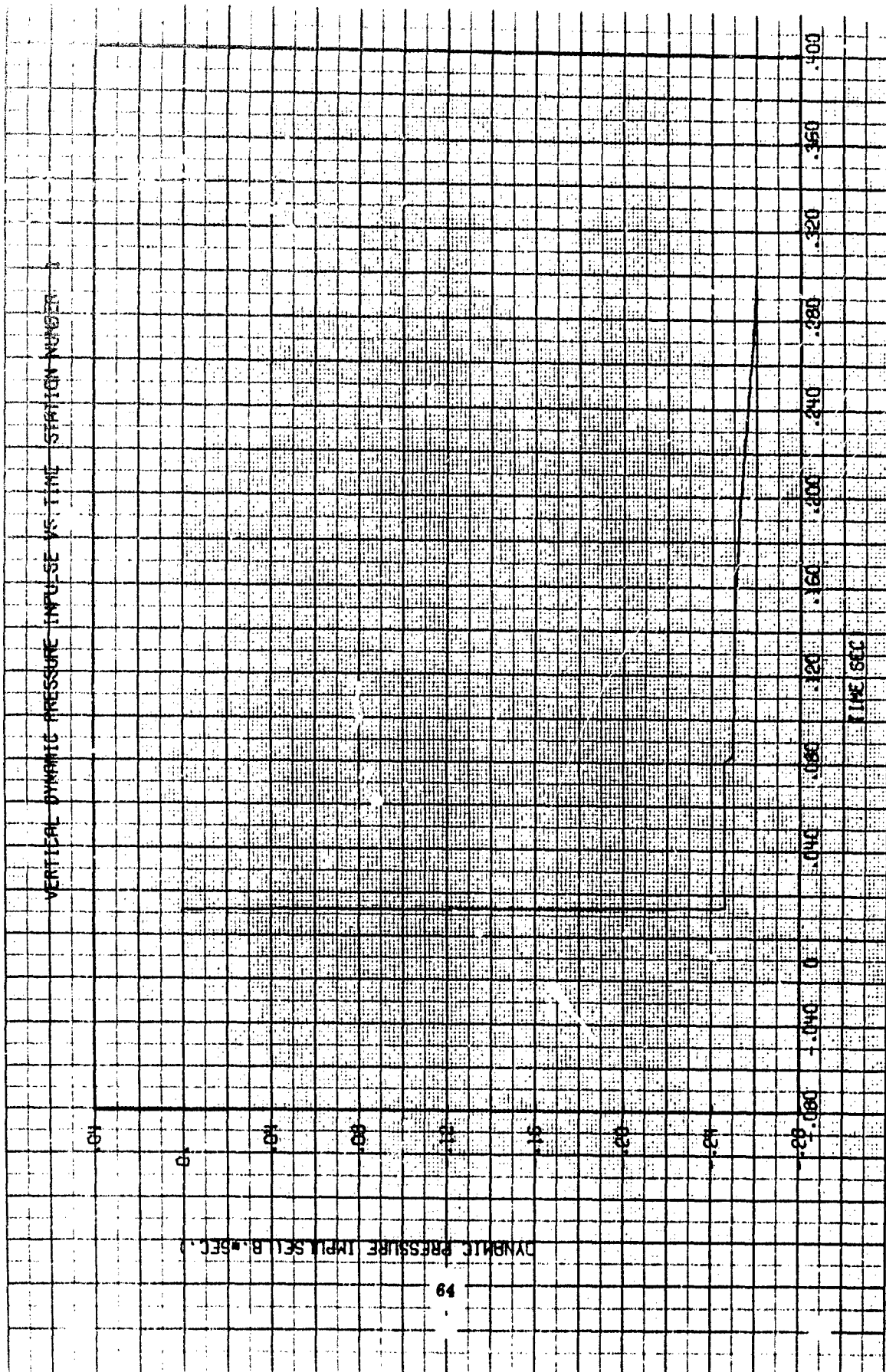
VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBERS

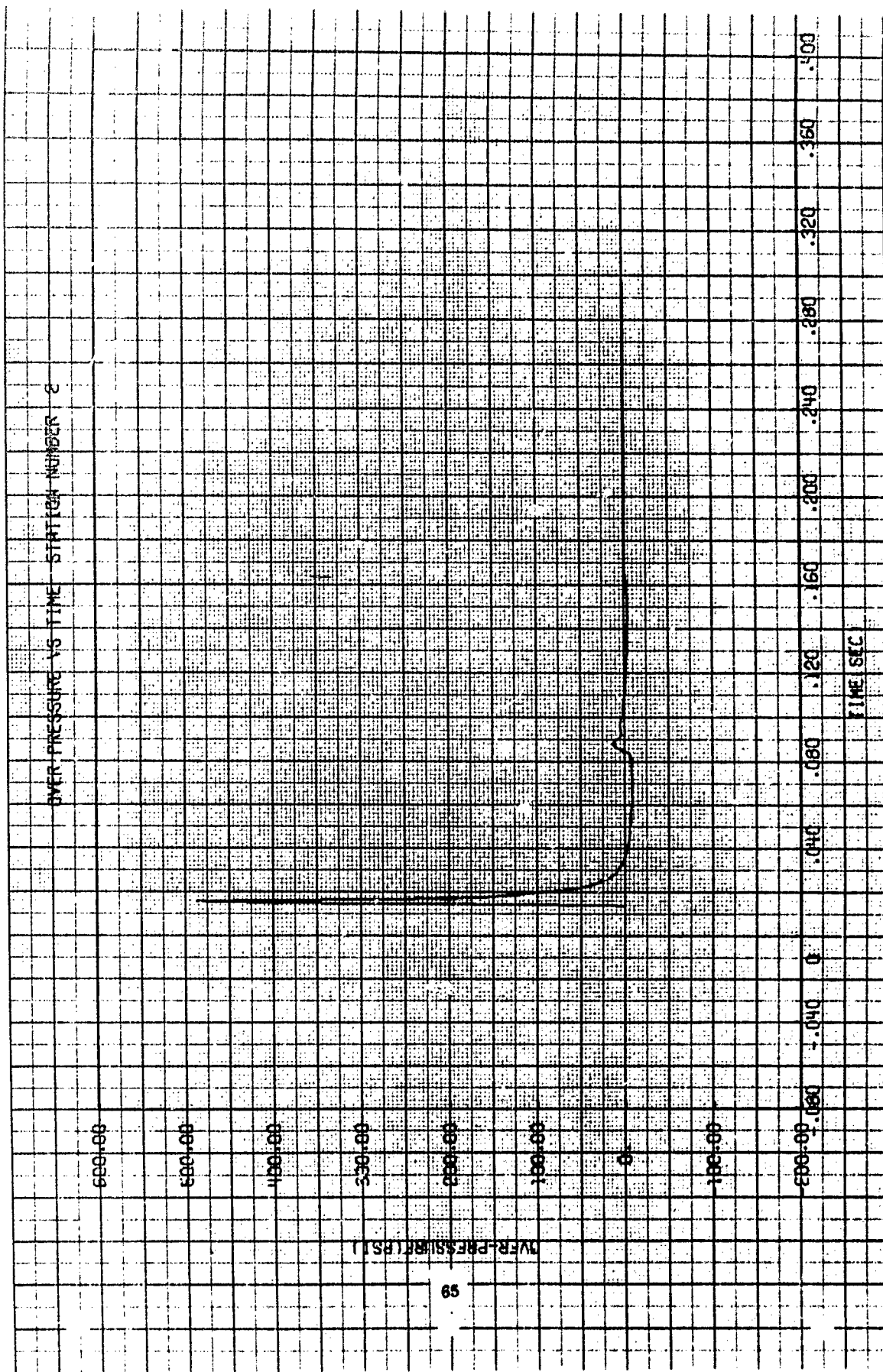


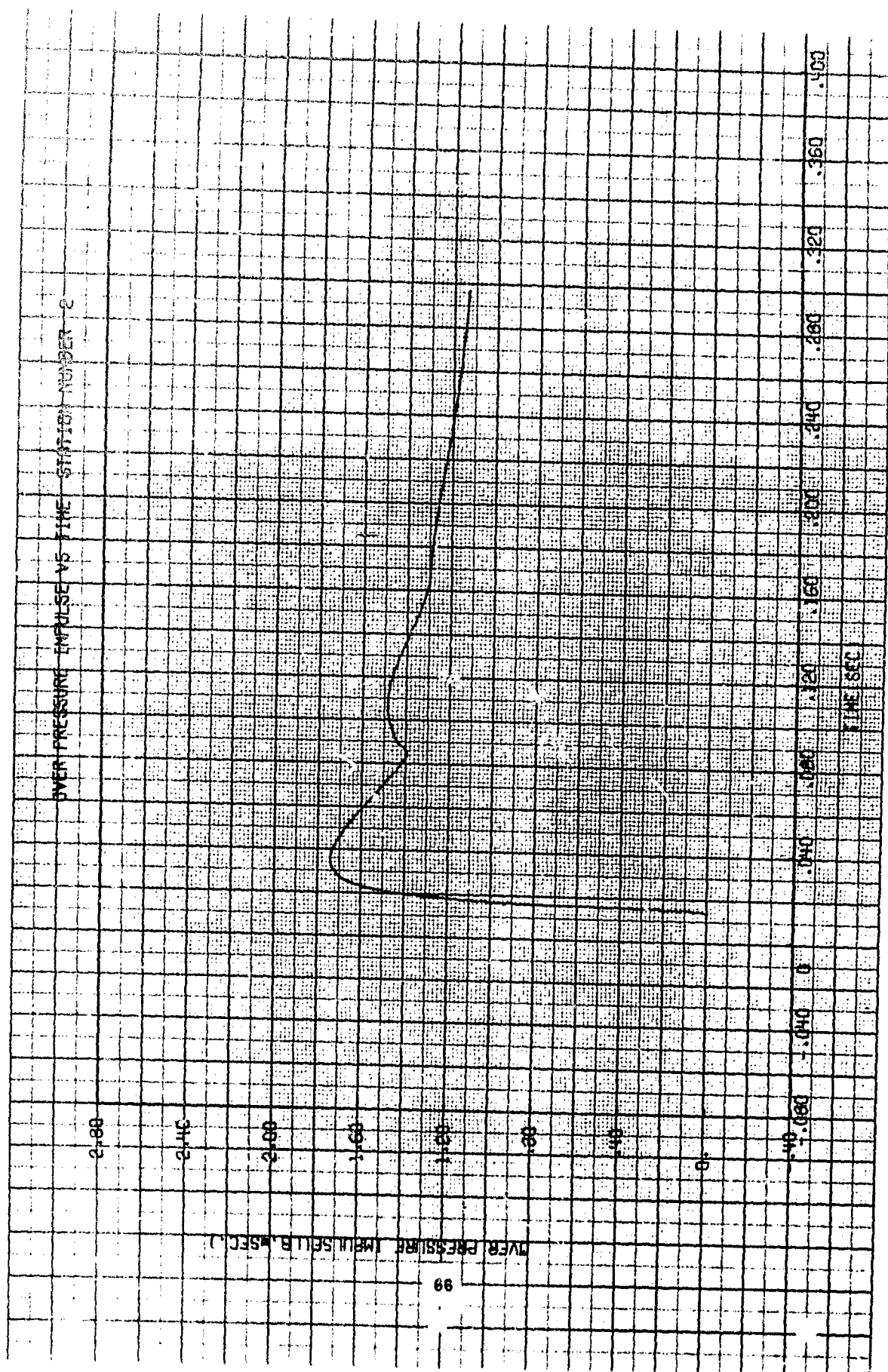
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER







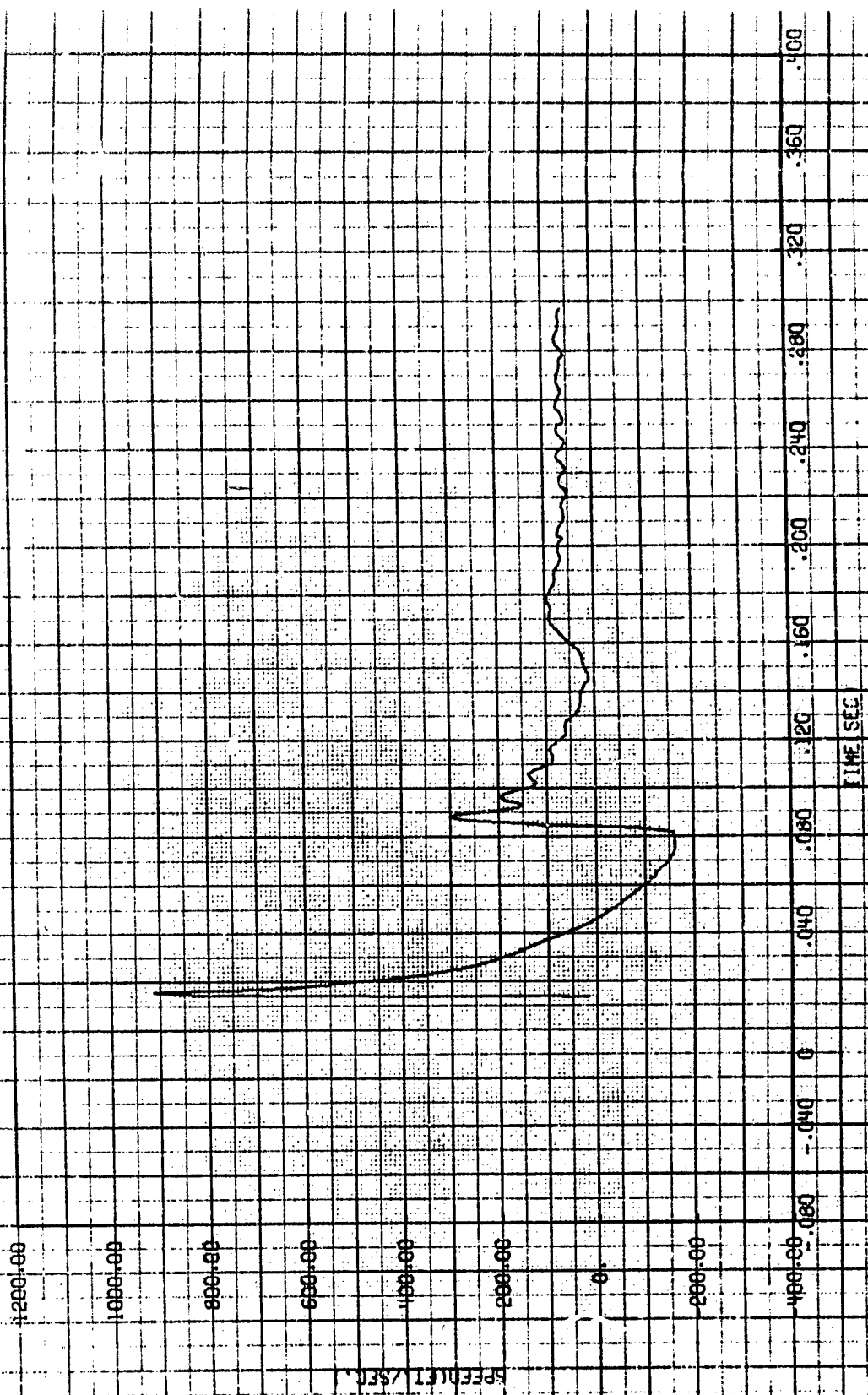




OVER PRESSURE IMPULSE (MBARS)

TIME (SEC)

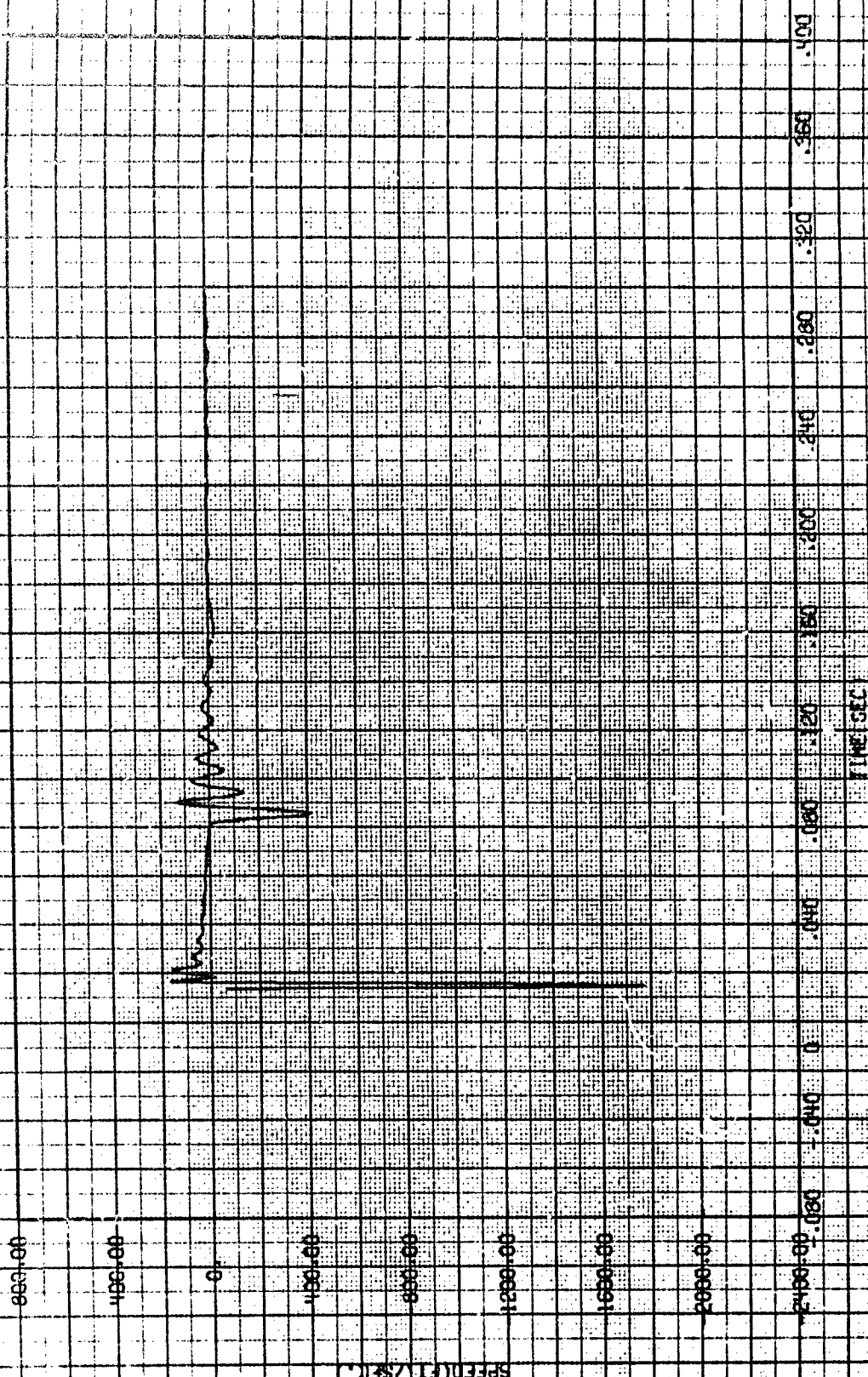
HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 2



SPEED (FT./SEC.)

TIME (SEC.)

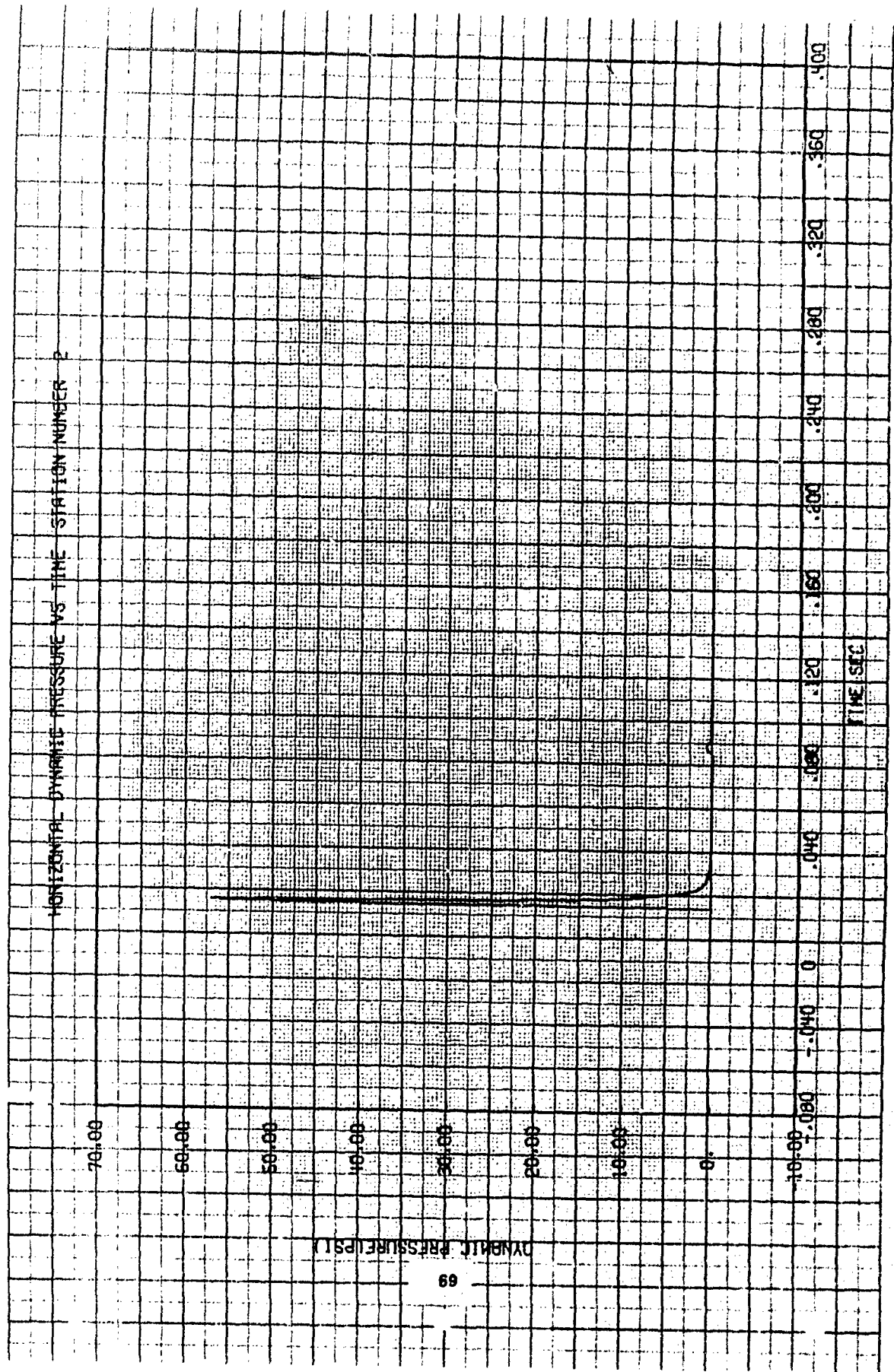
VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 2



VELOCITY (FT./SEC.)

TIME (SEC.)

HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 2



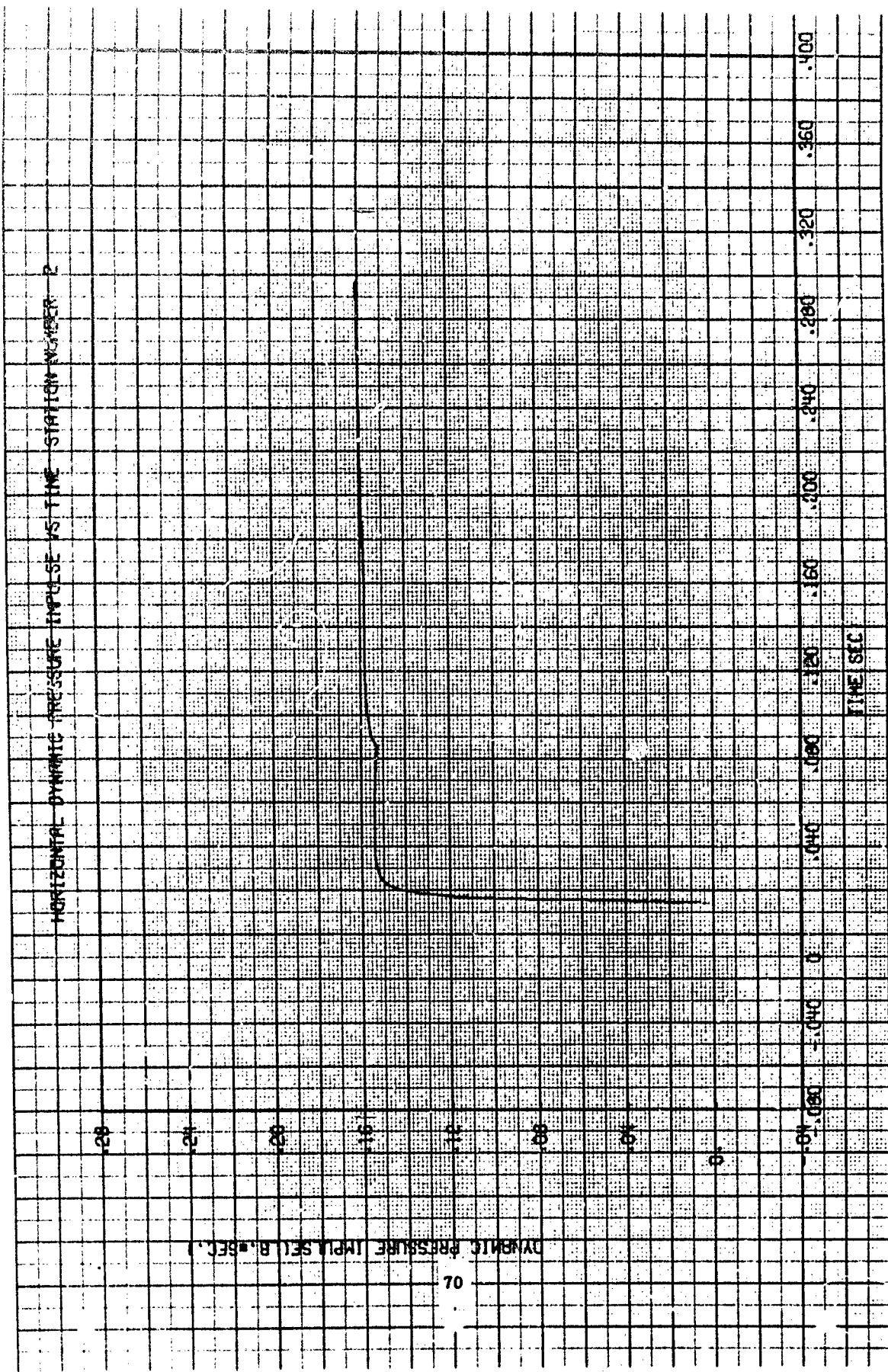
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 2

10
9
8
7
6
5
4
3
2
1

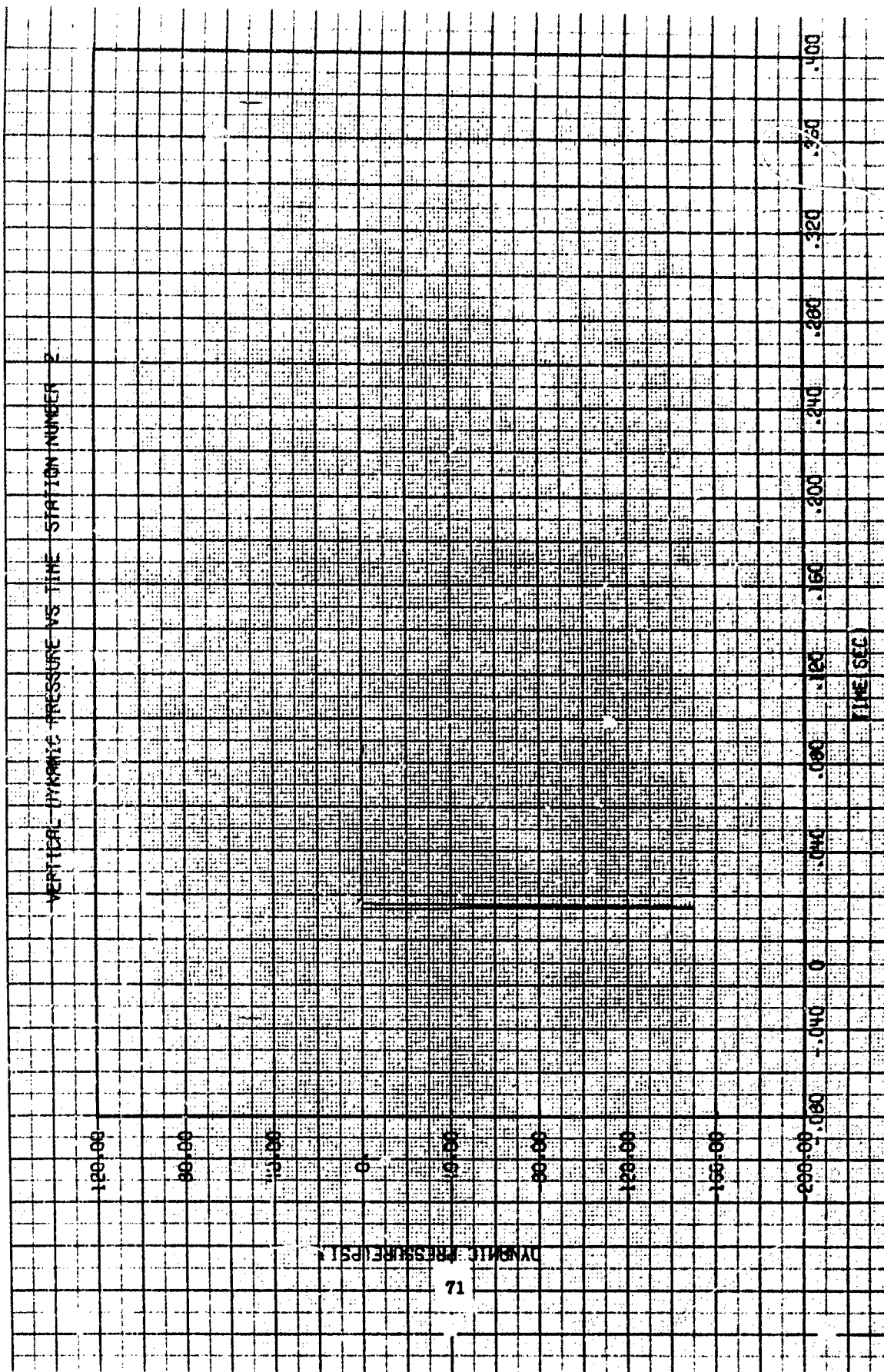
DYNAMIC PRESSURE (LBS./SQ. IN.)

0.000 0.040 0.080 0.120 0.160 0.200 0.240 0.280 0.320 0.360 0.400

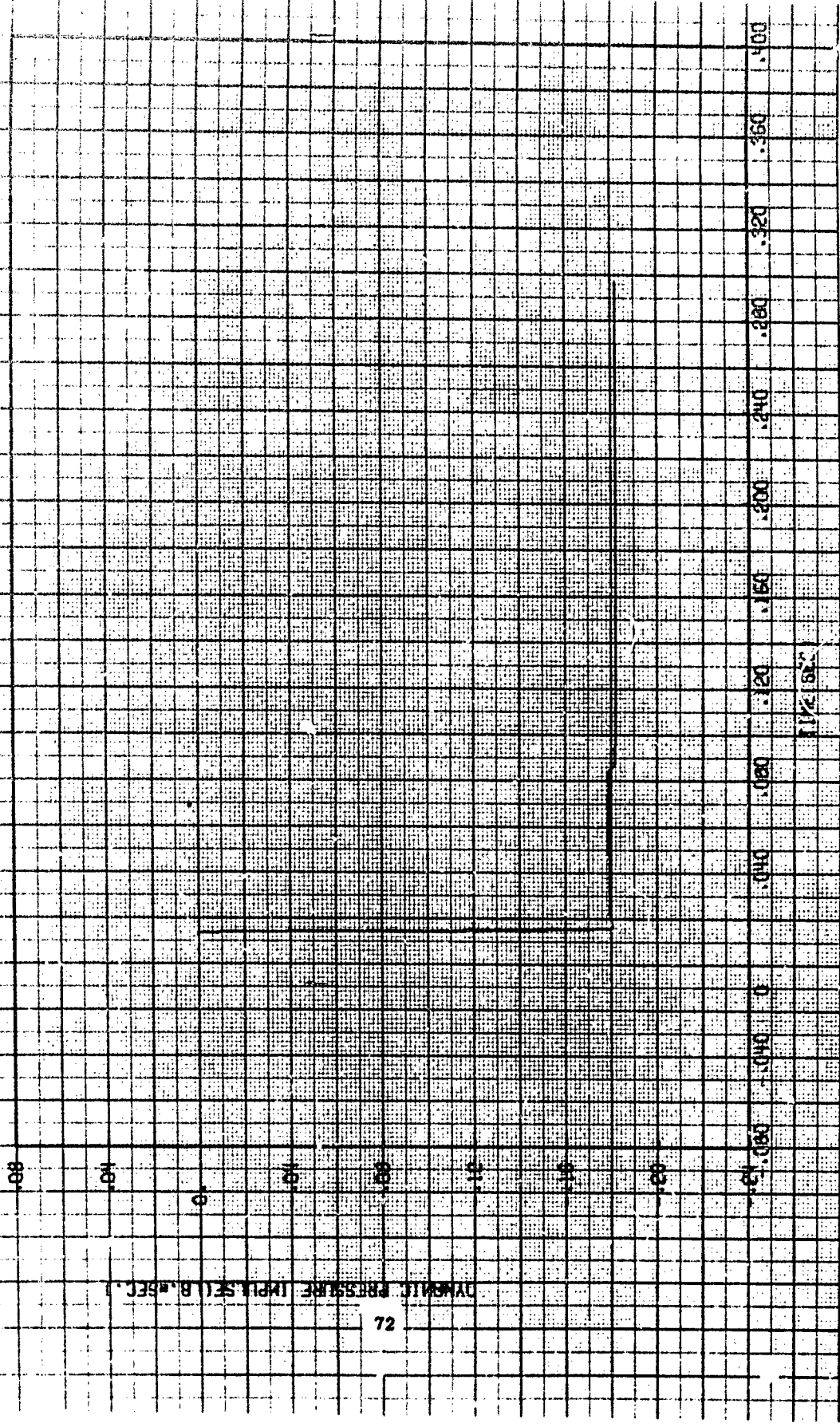
TIME SEC



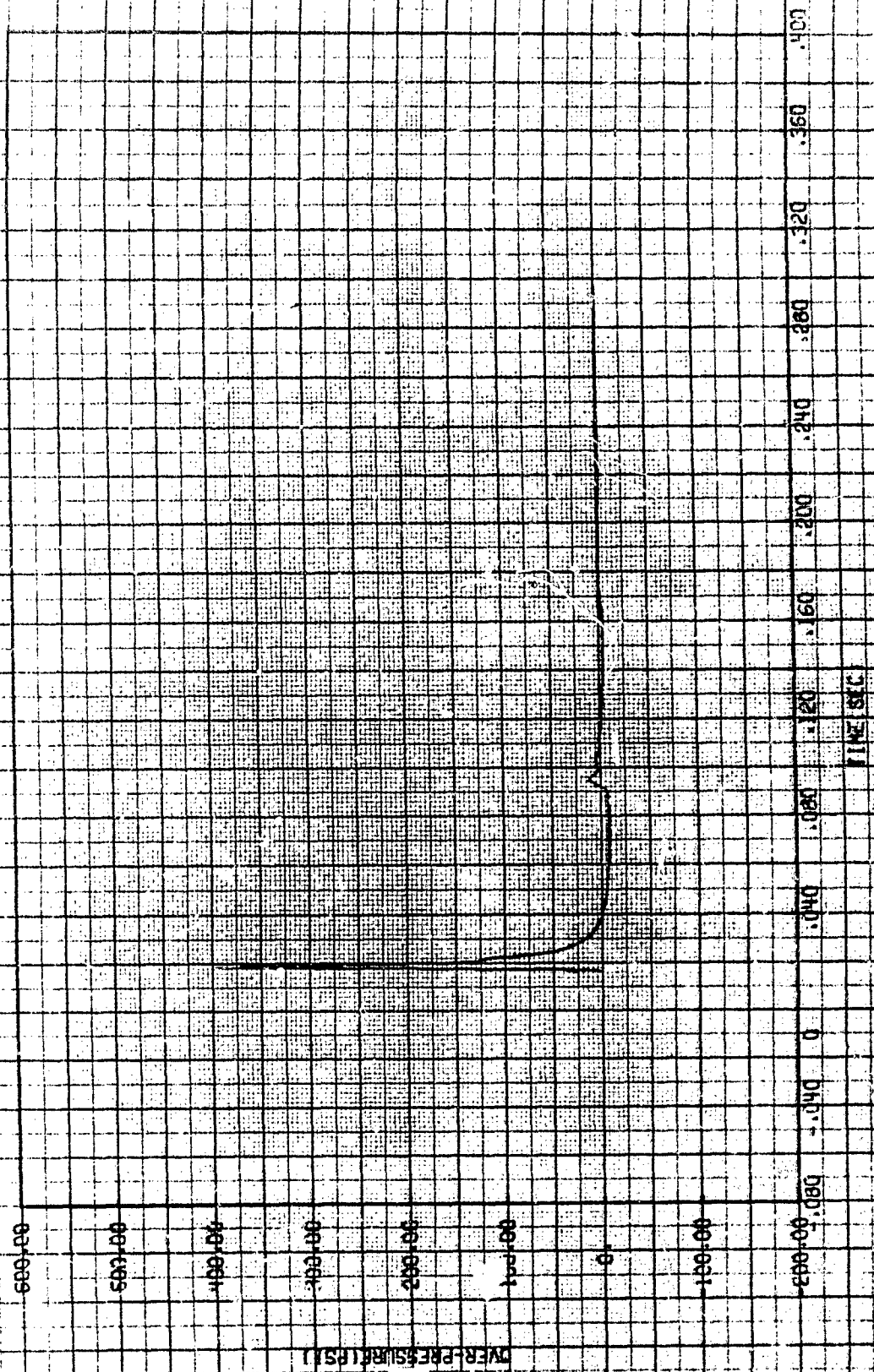
VERTICAL DYNAMIC PRESSURE VS TIME STATION NUMBER 2



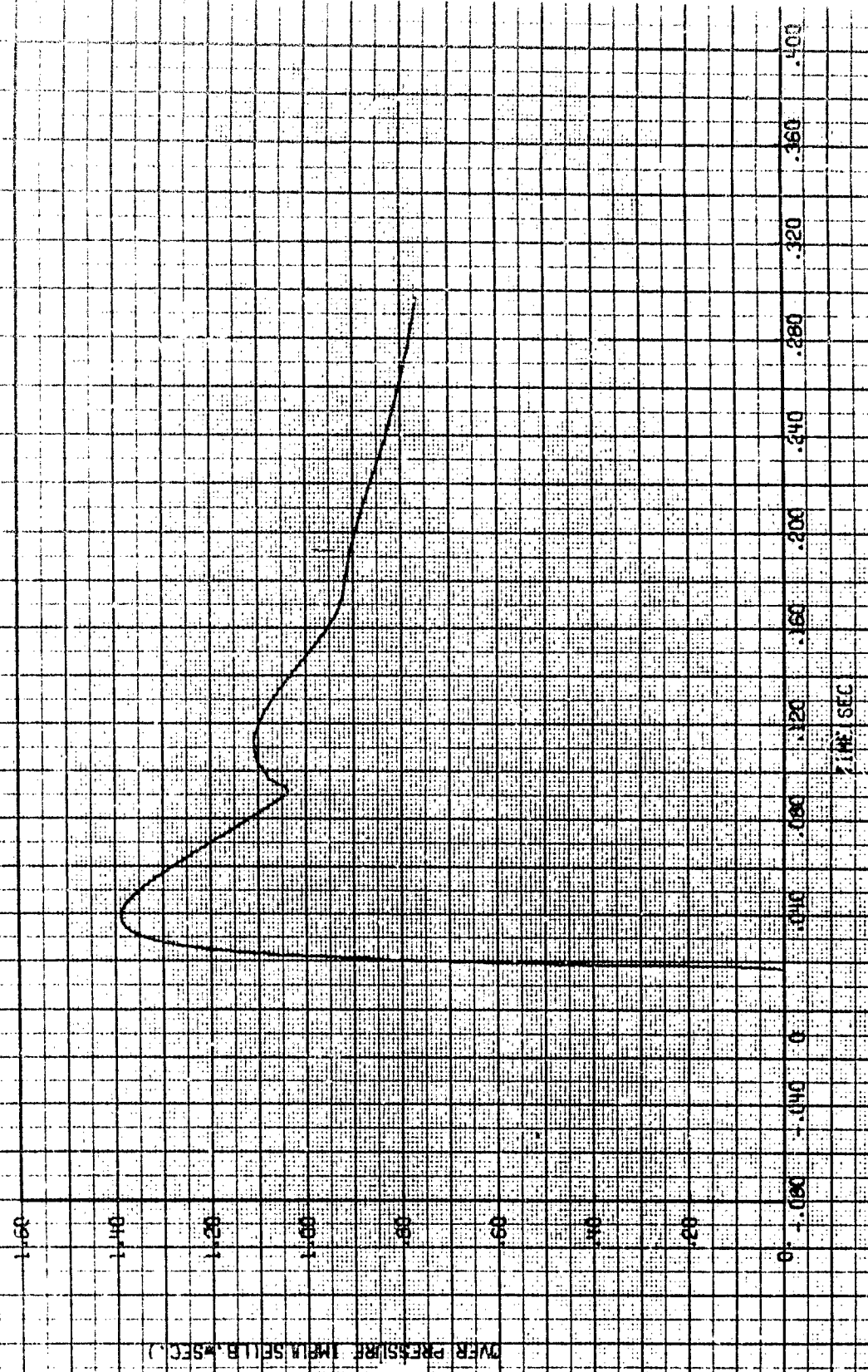
VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 2



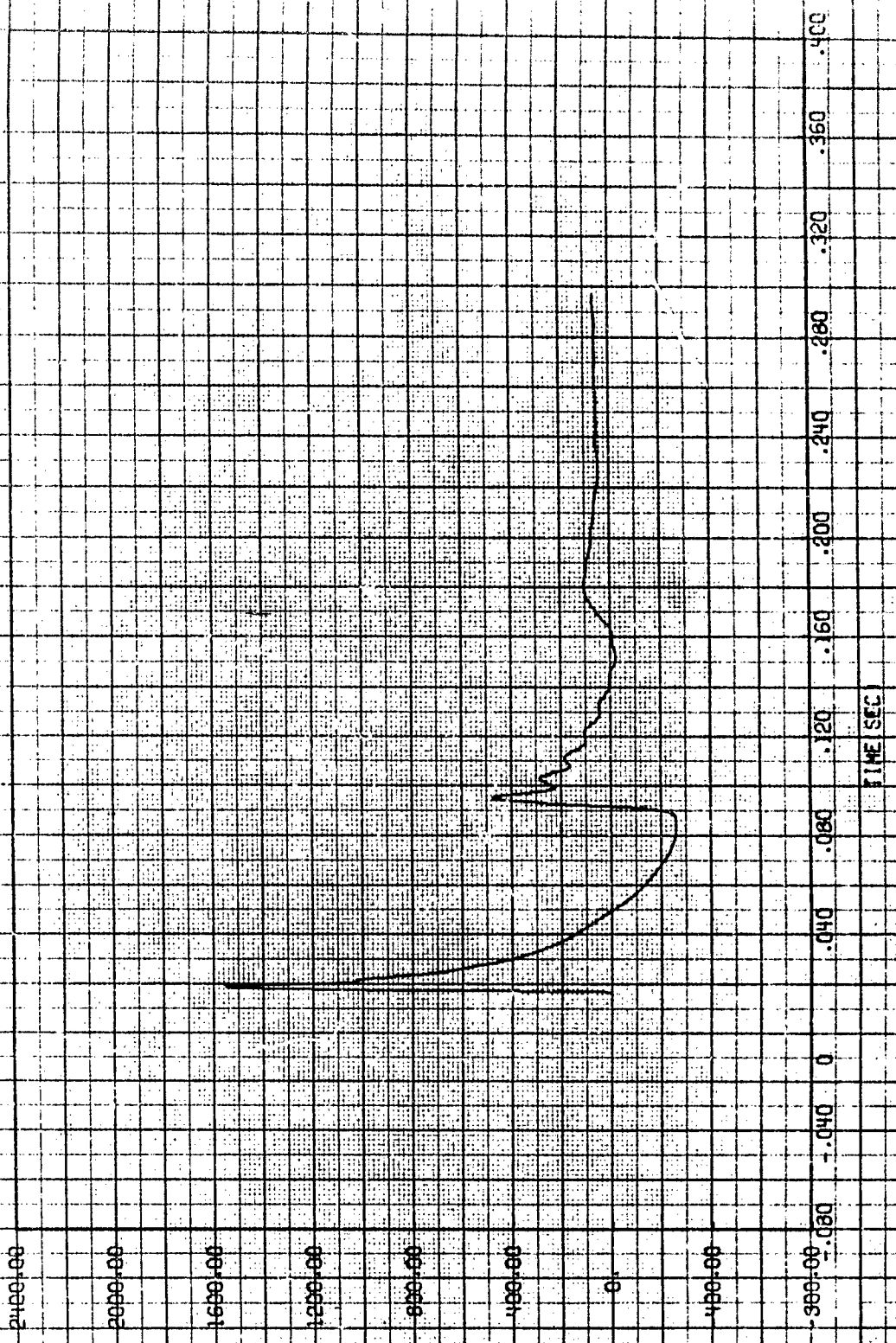
OVER PRESSURE VS TIME STATION NUMBER 3



OVER PRESSURE IMPULSE VS TIME STATION NUMBER 5



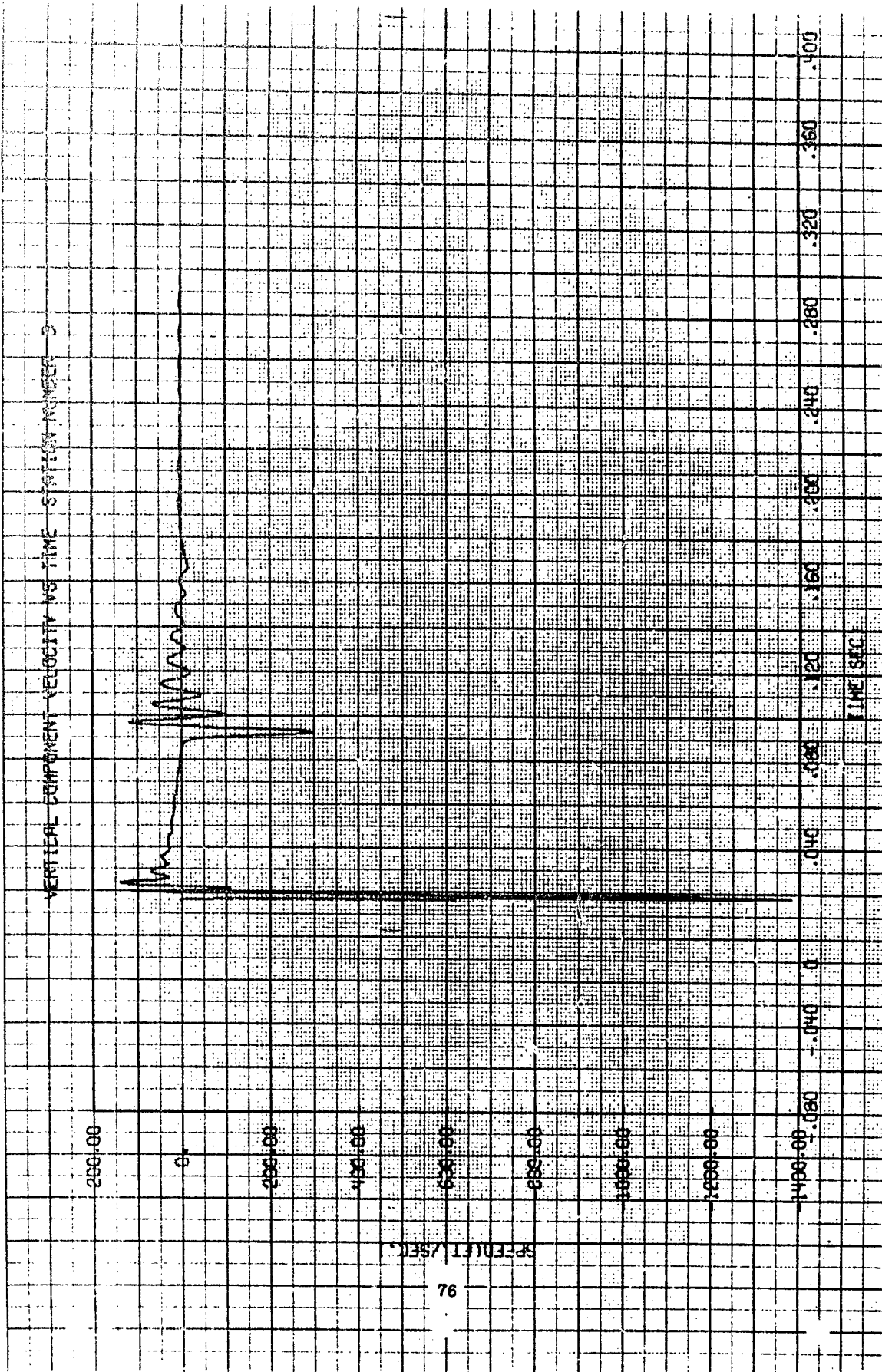
HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 5



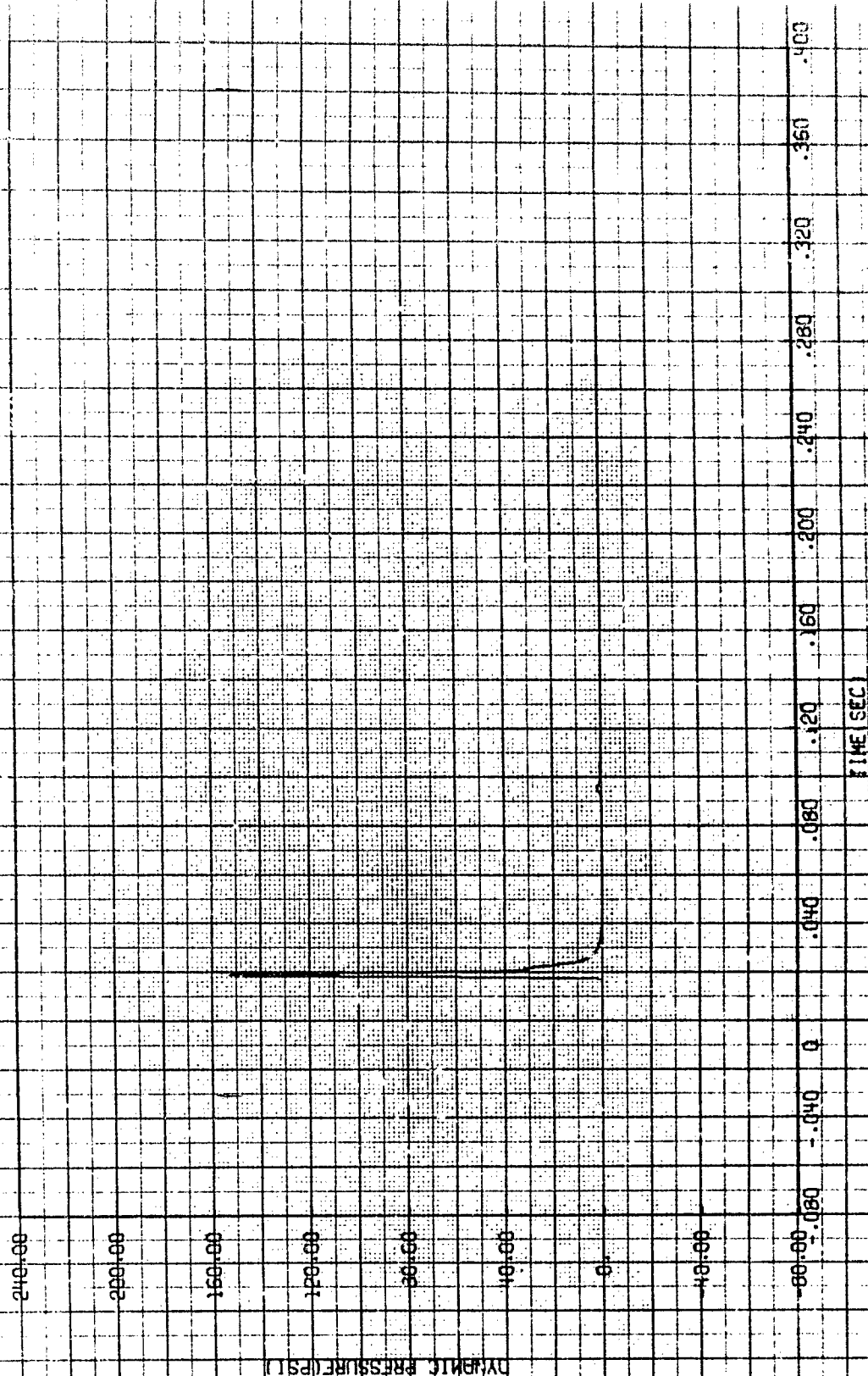
SPEED (FT./SEC.)

TIME (SEC.)

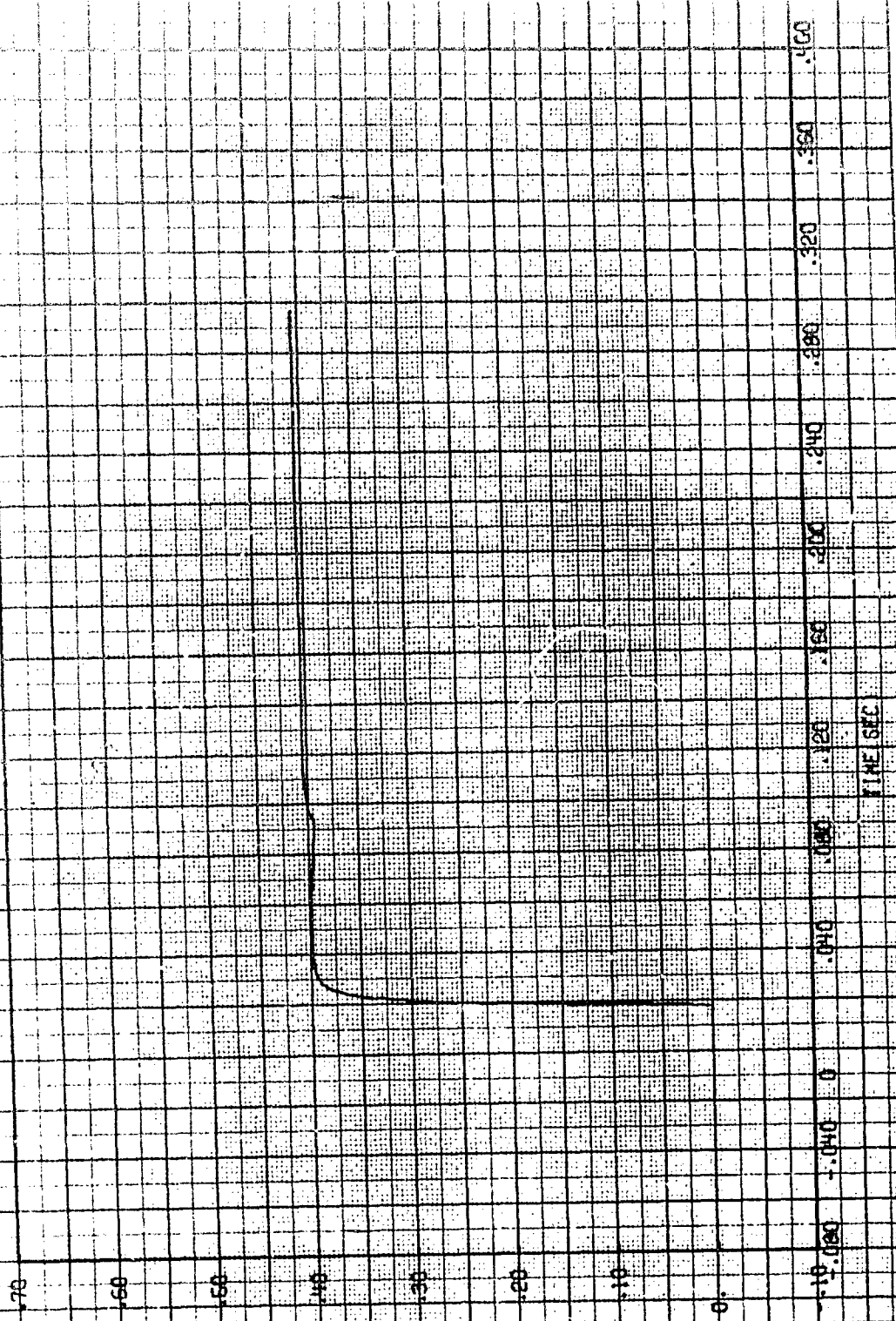
7



HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 3



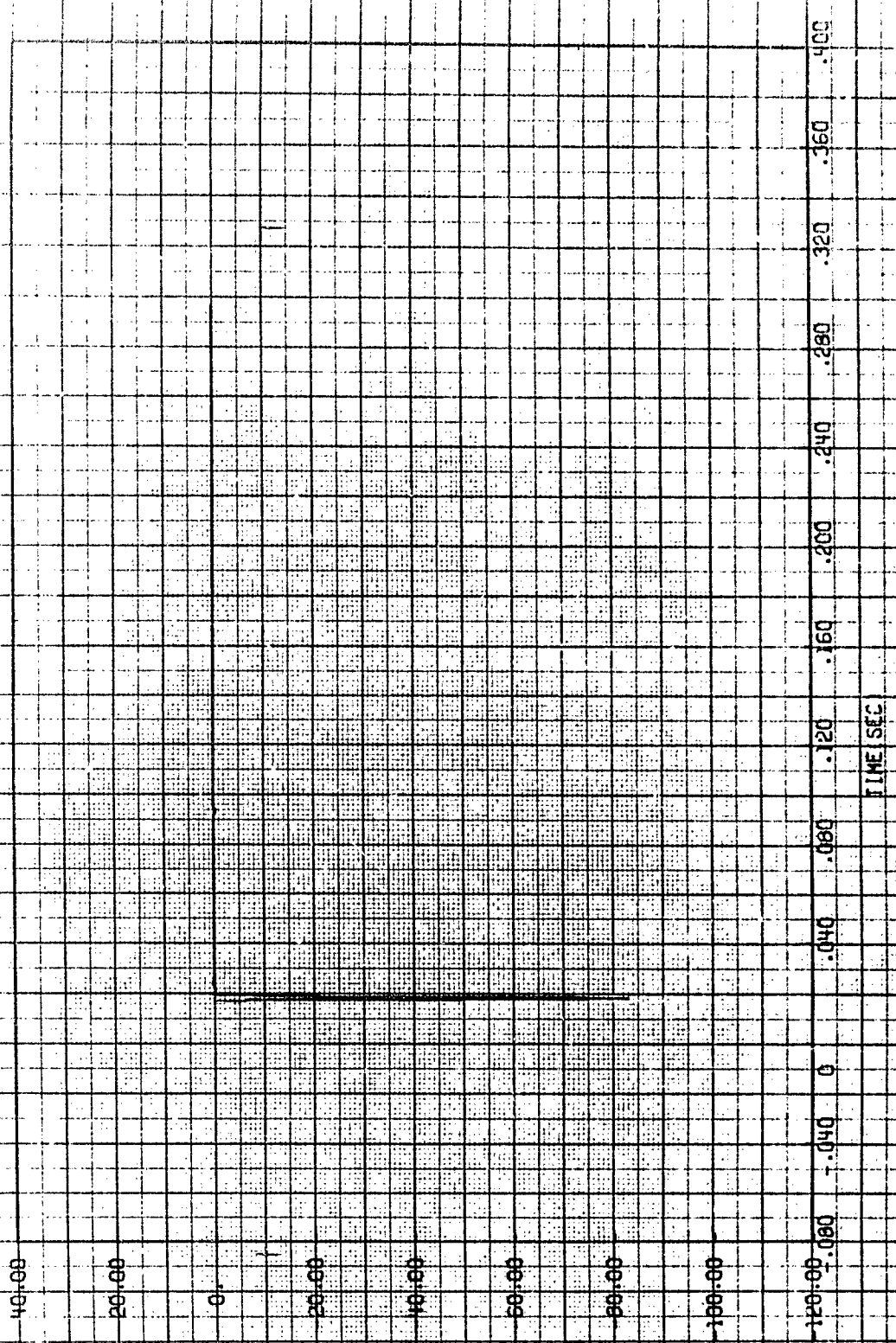
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER



DYNAMIC PRESSURE (LPIA SEC. IN. SEC.)

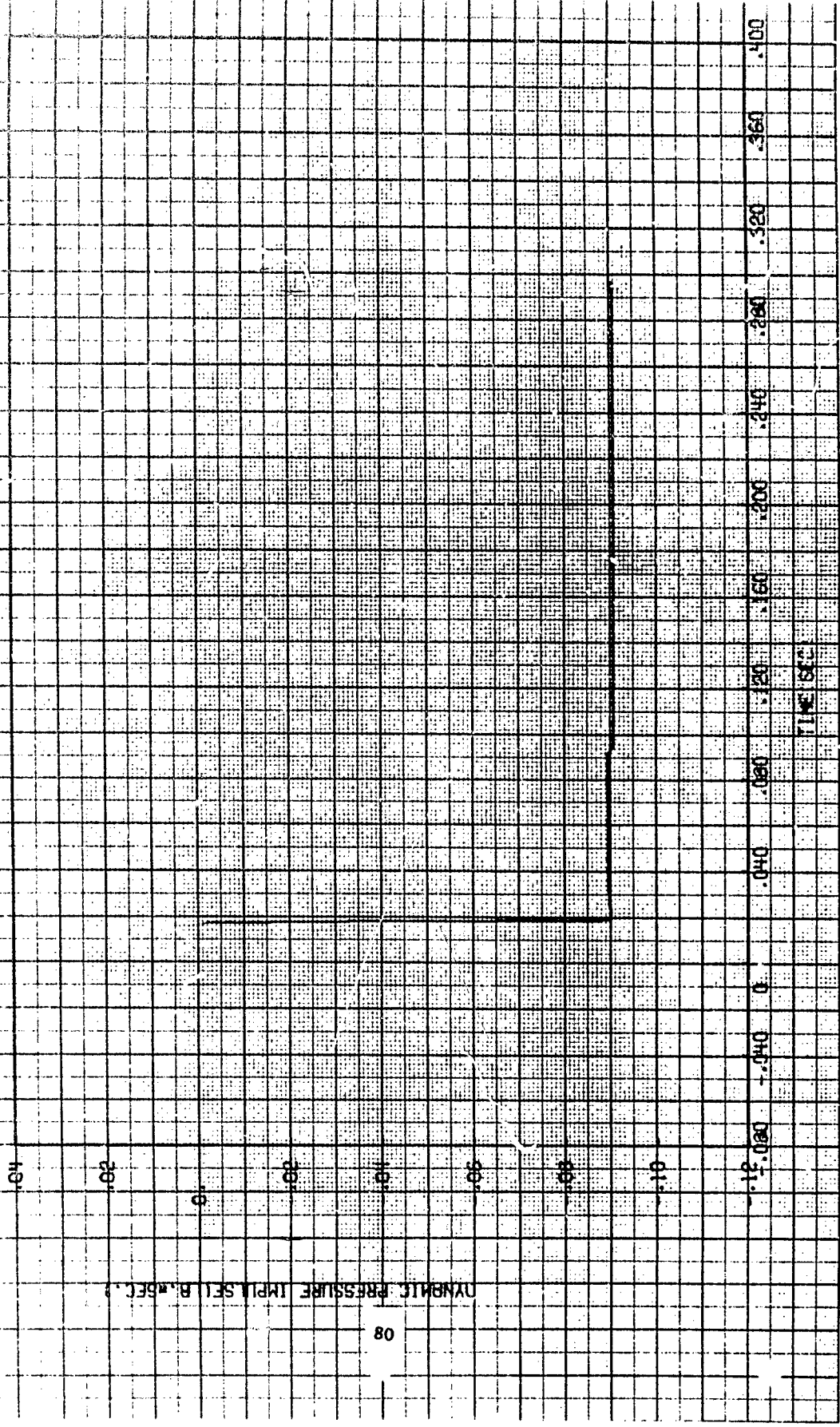
TIME (SEC.)

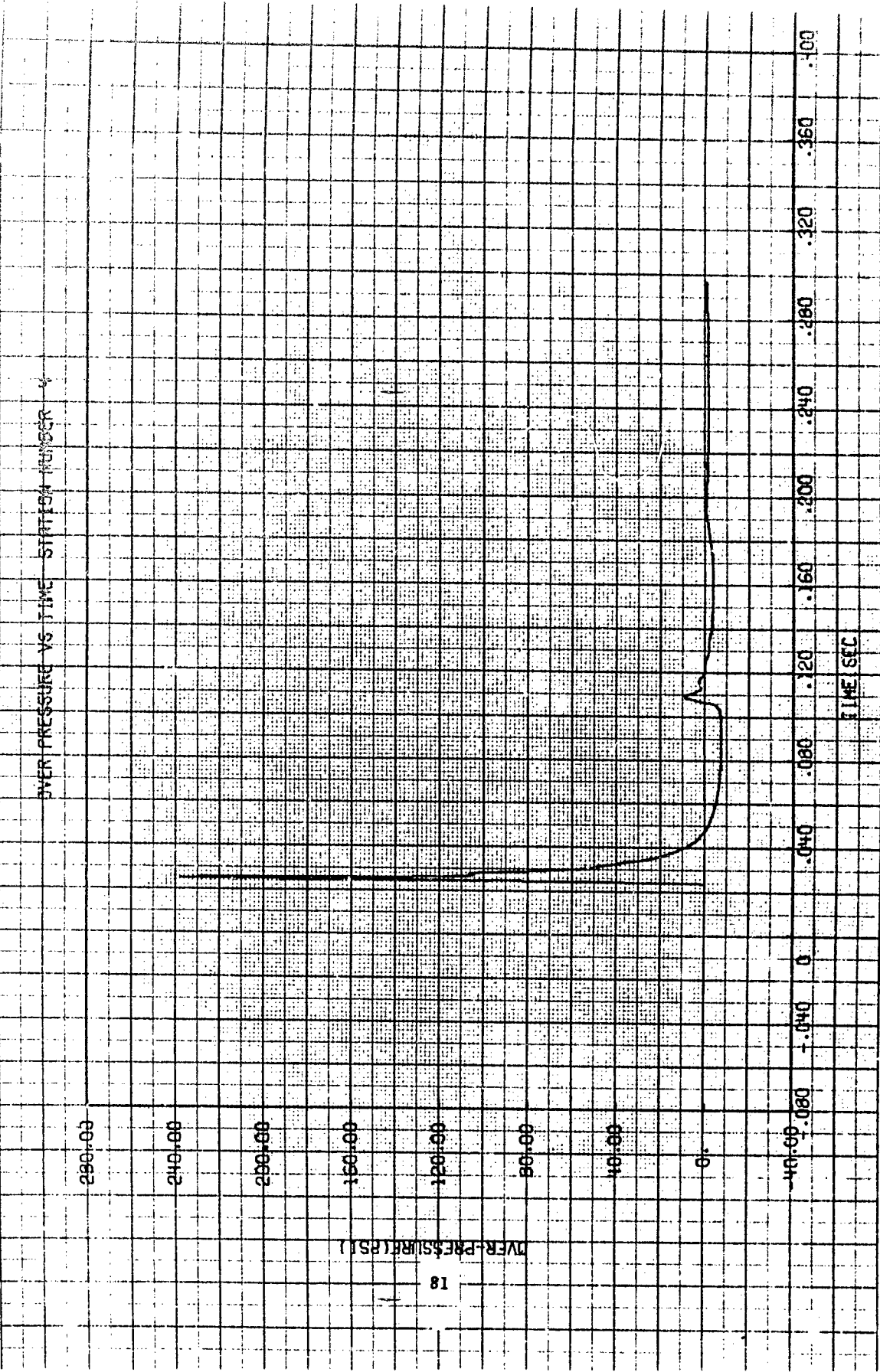
VERTICAL DYNAMIC PRESSURE VS TIME STATION NUMBER 3

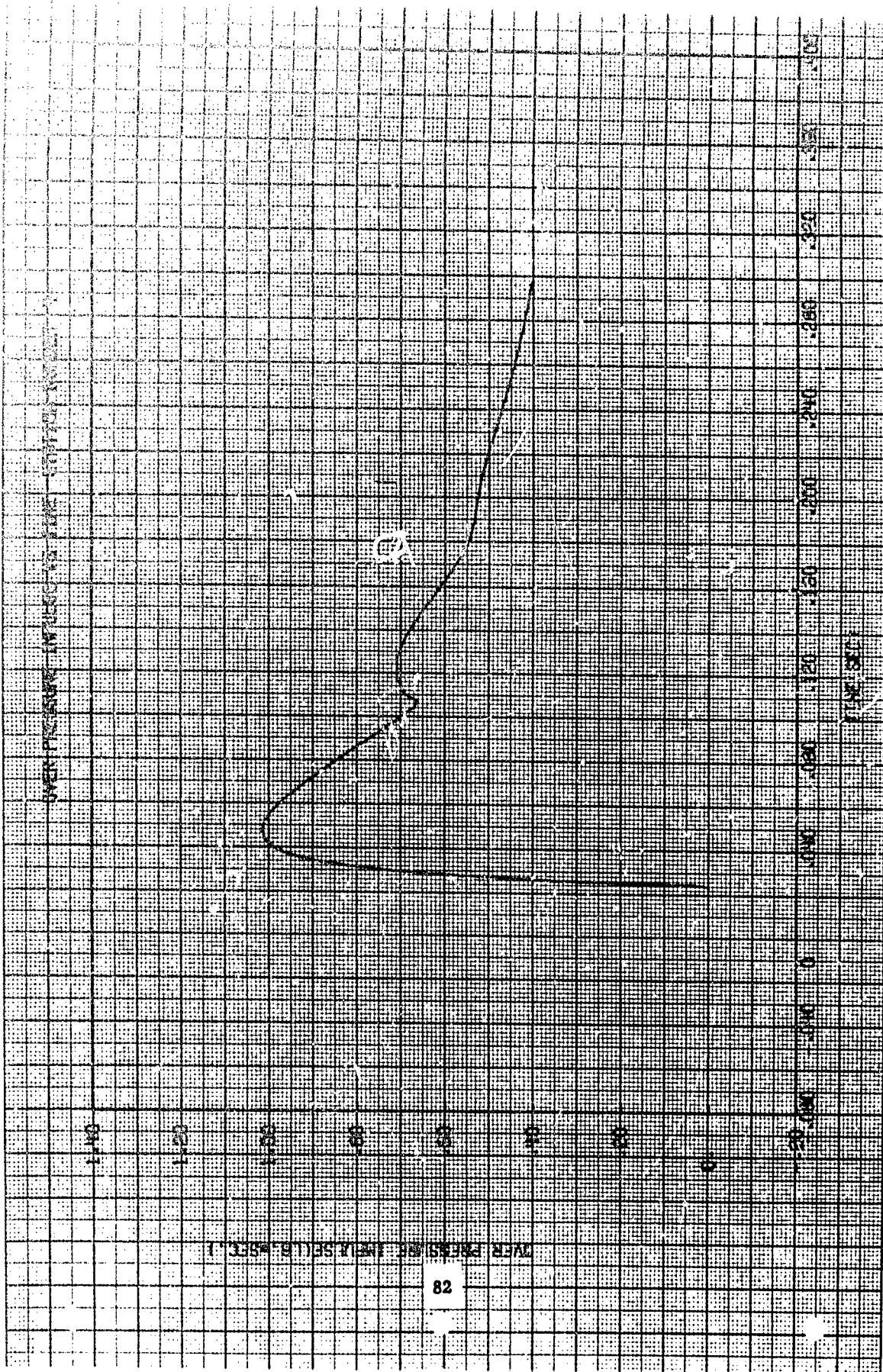


DYNAMIC PRESSURE (PSI)

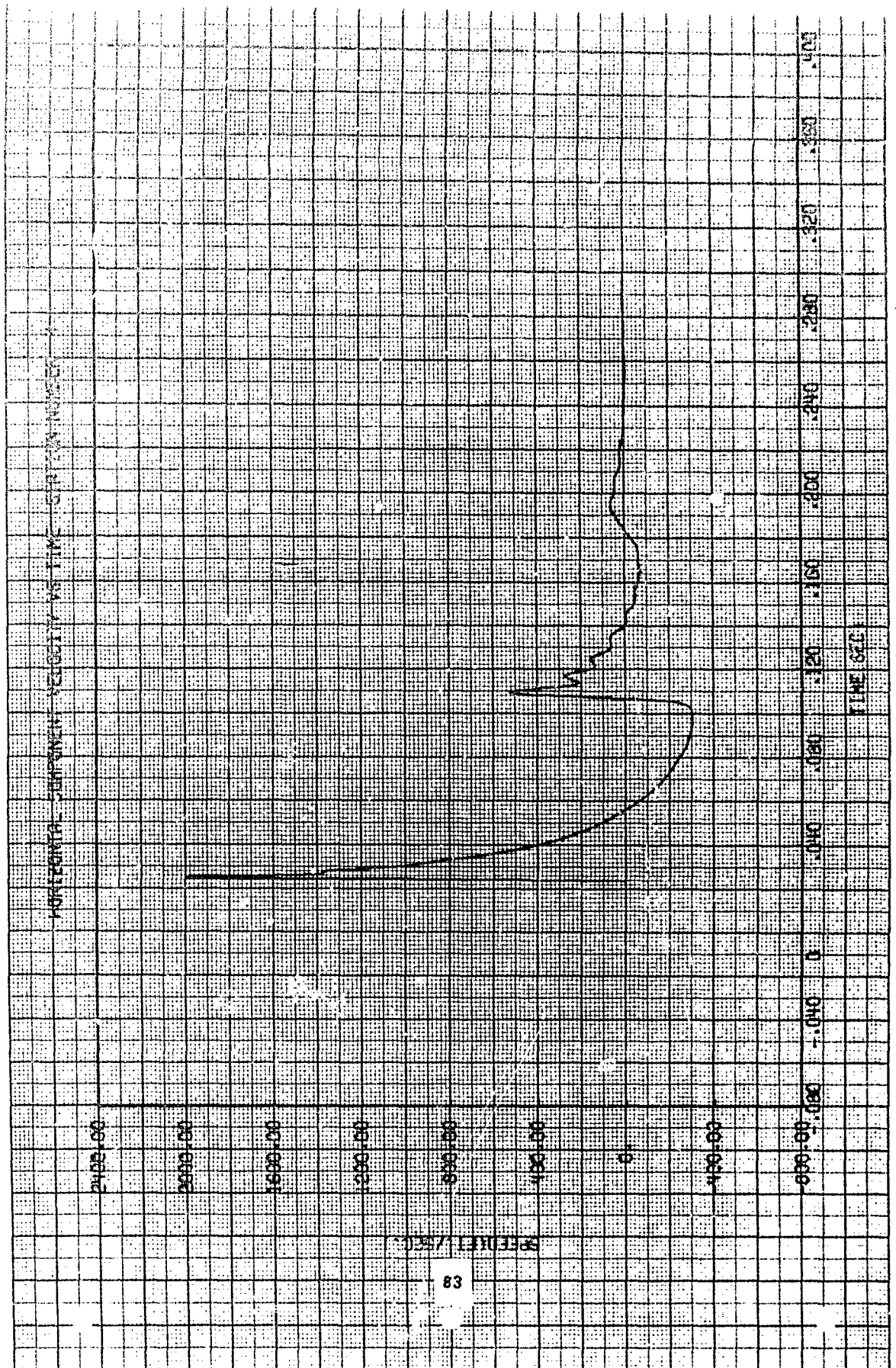
VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 3

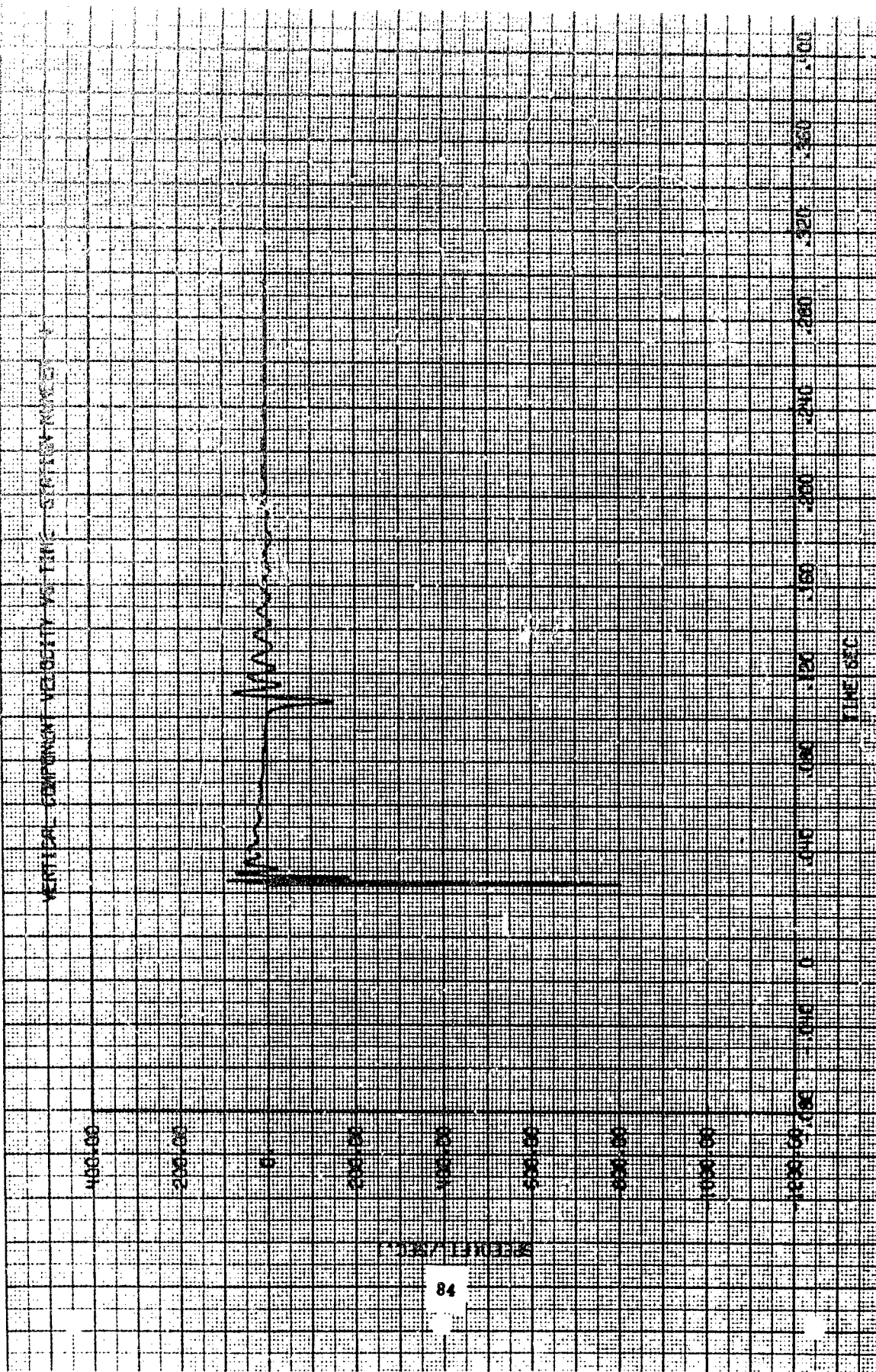


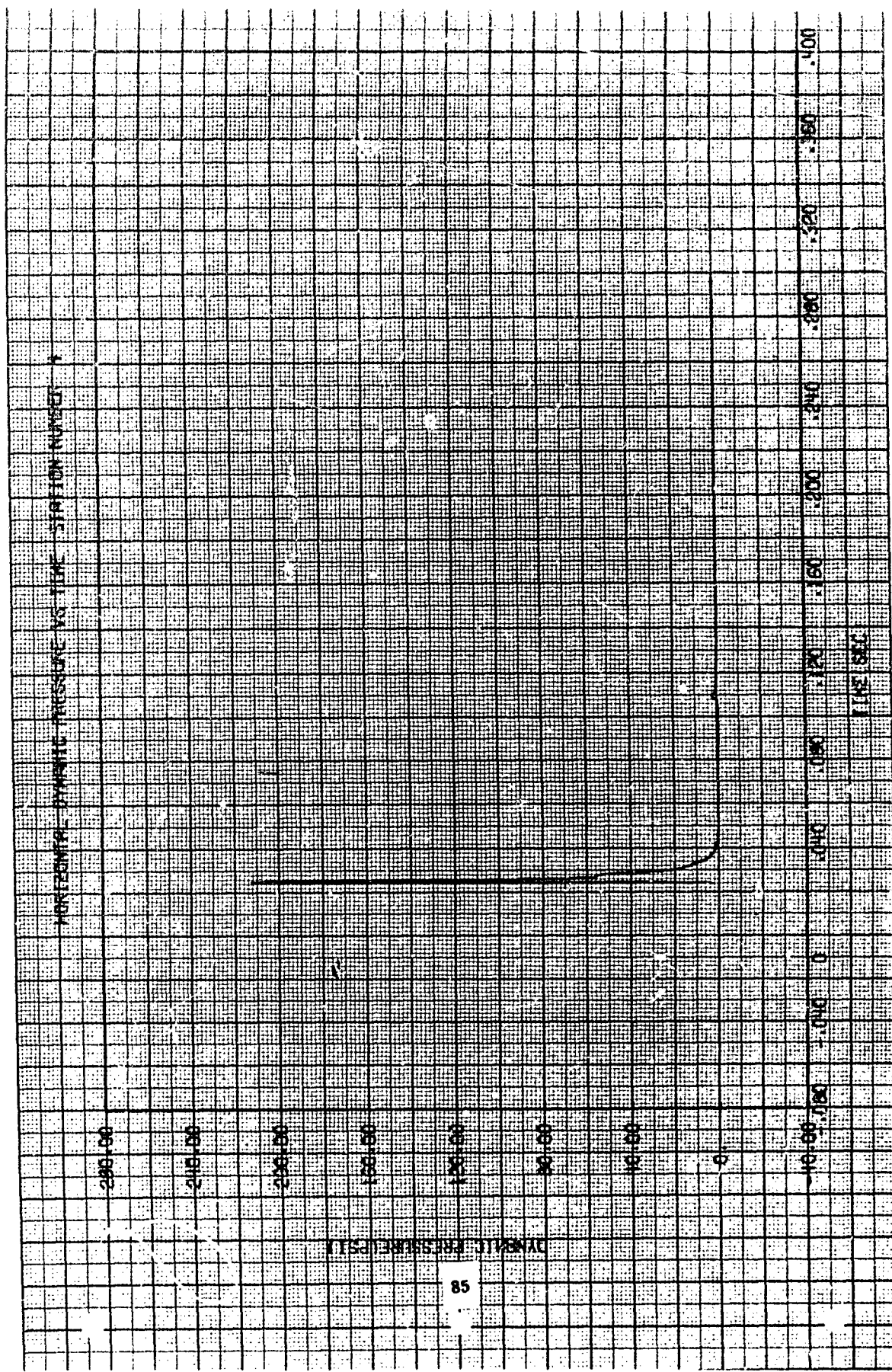




WELL PRESSURE IN TUBES TO WELLS (PSI)







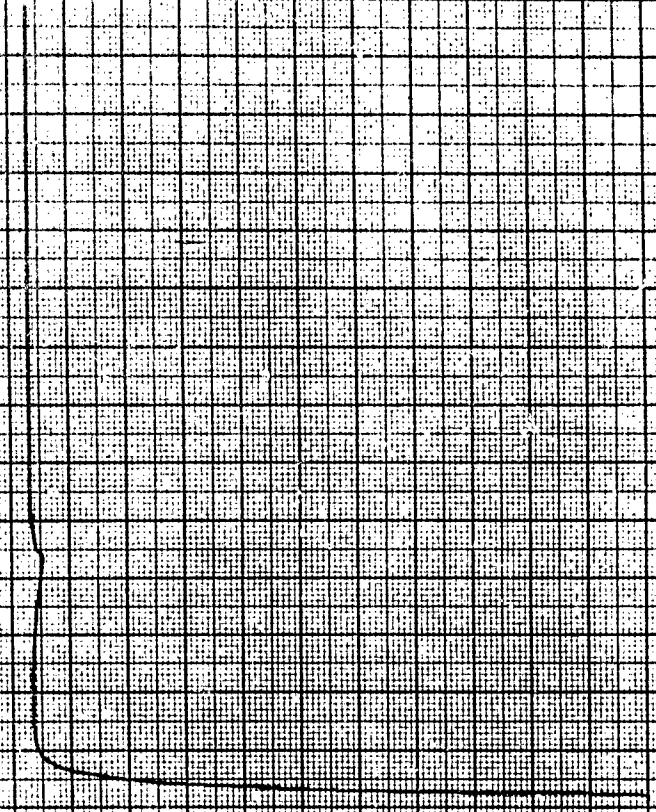
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 4

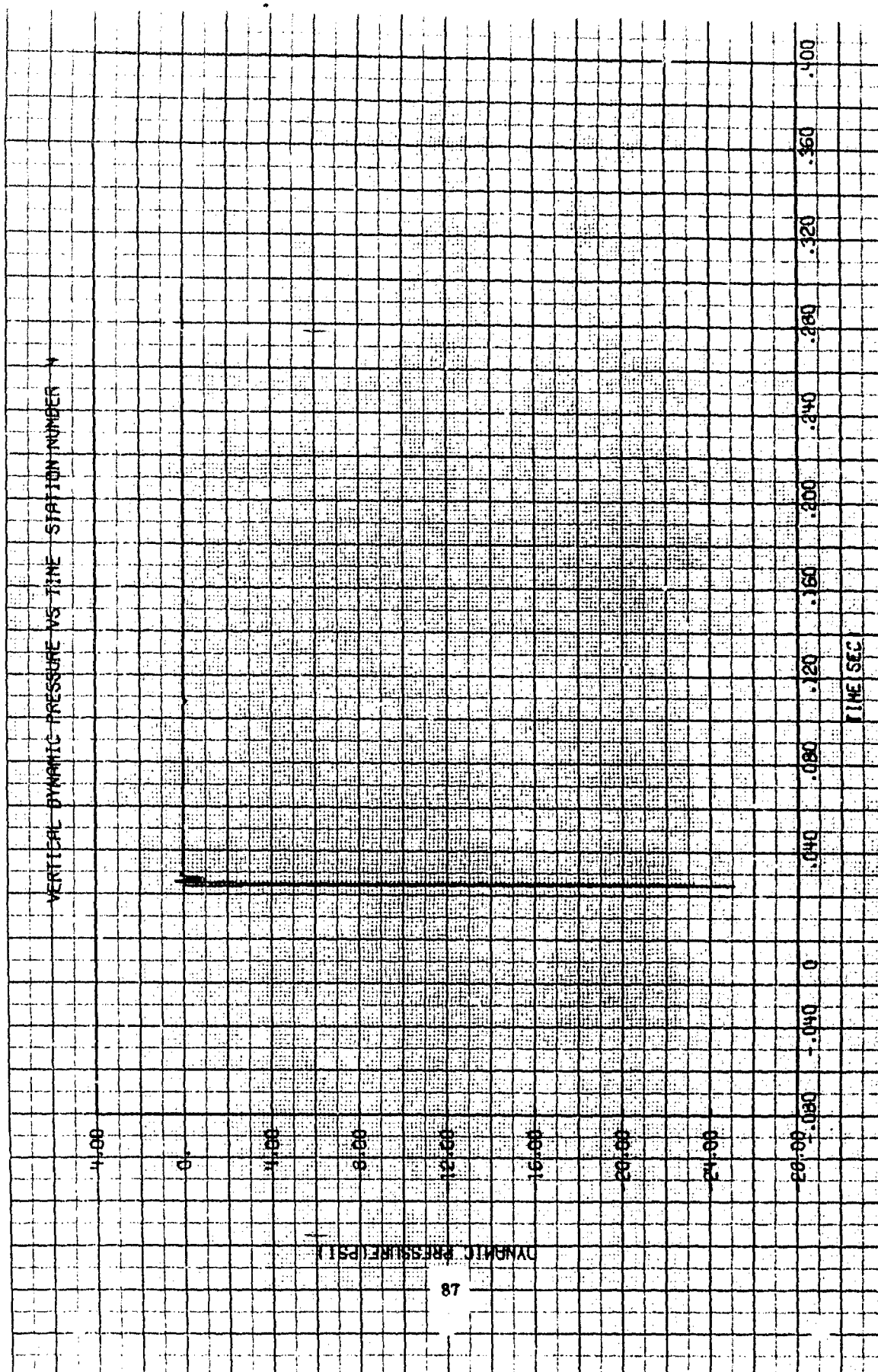
70
60
50
40
30
20
10
0

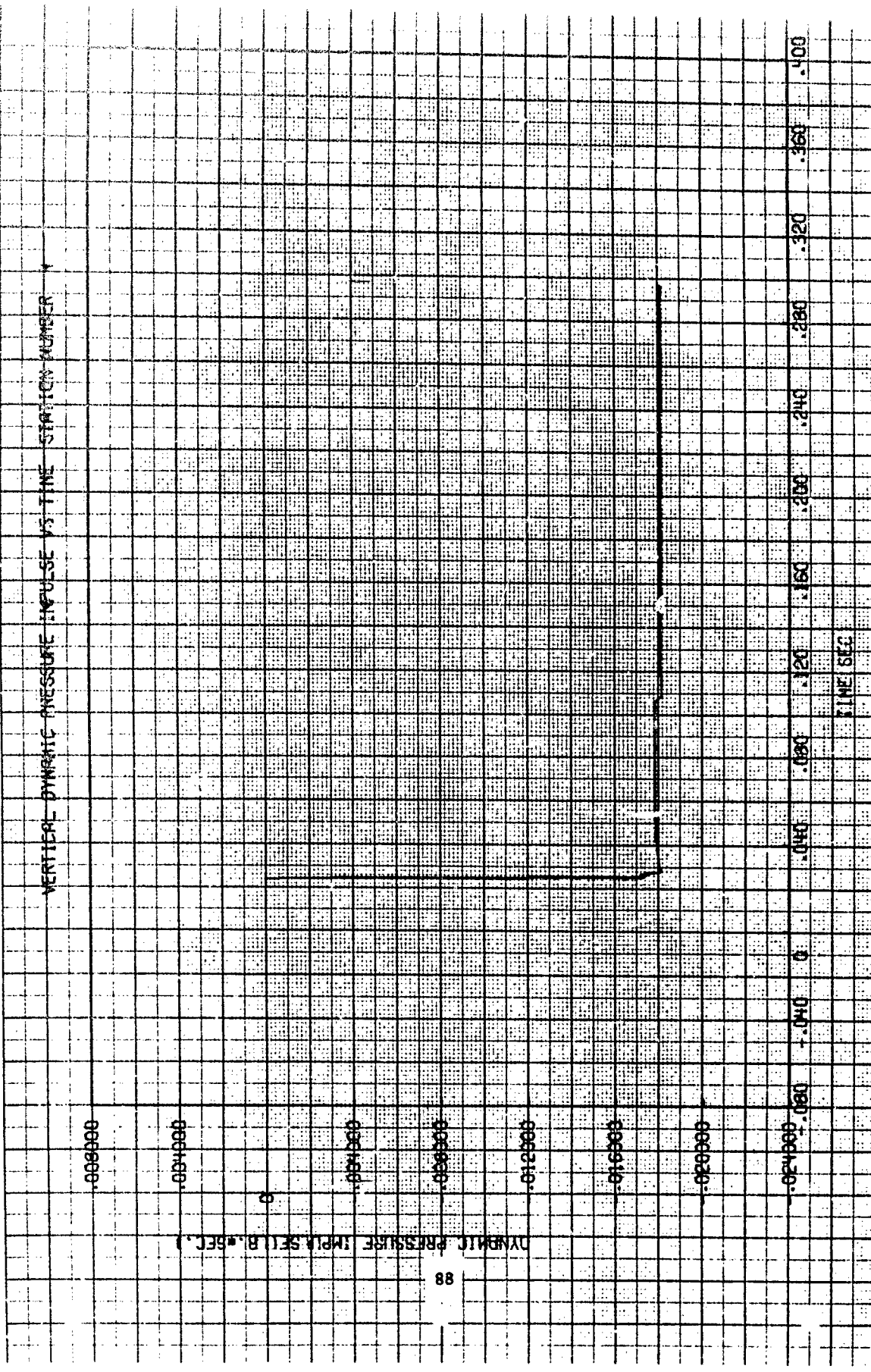
DYNAMIC PRESSURE IMPULSE (L.B./SEC.)

98

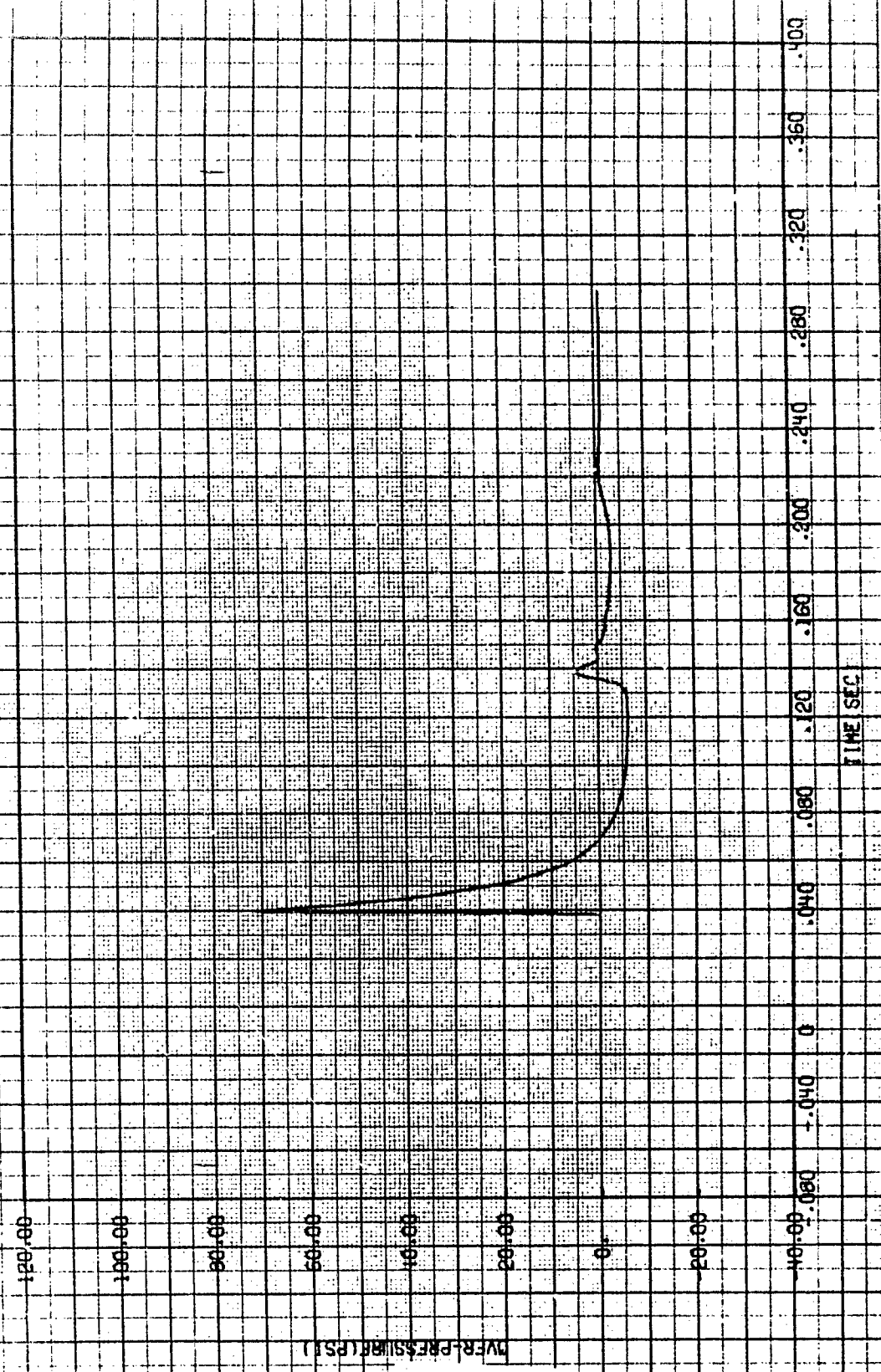
0.000 0.040 0.080 0.120 0.160 0.200 0.240 0.280 0.320 0.360 0.400
TIME SEC



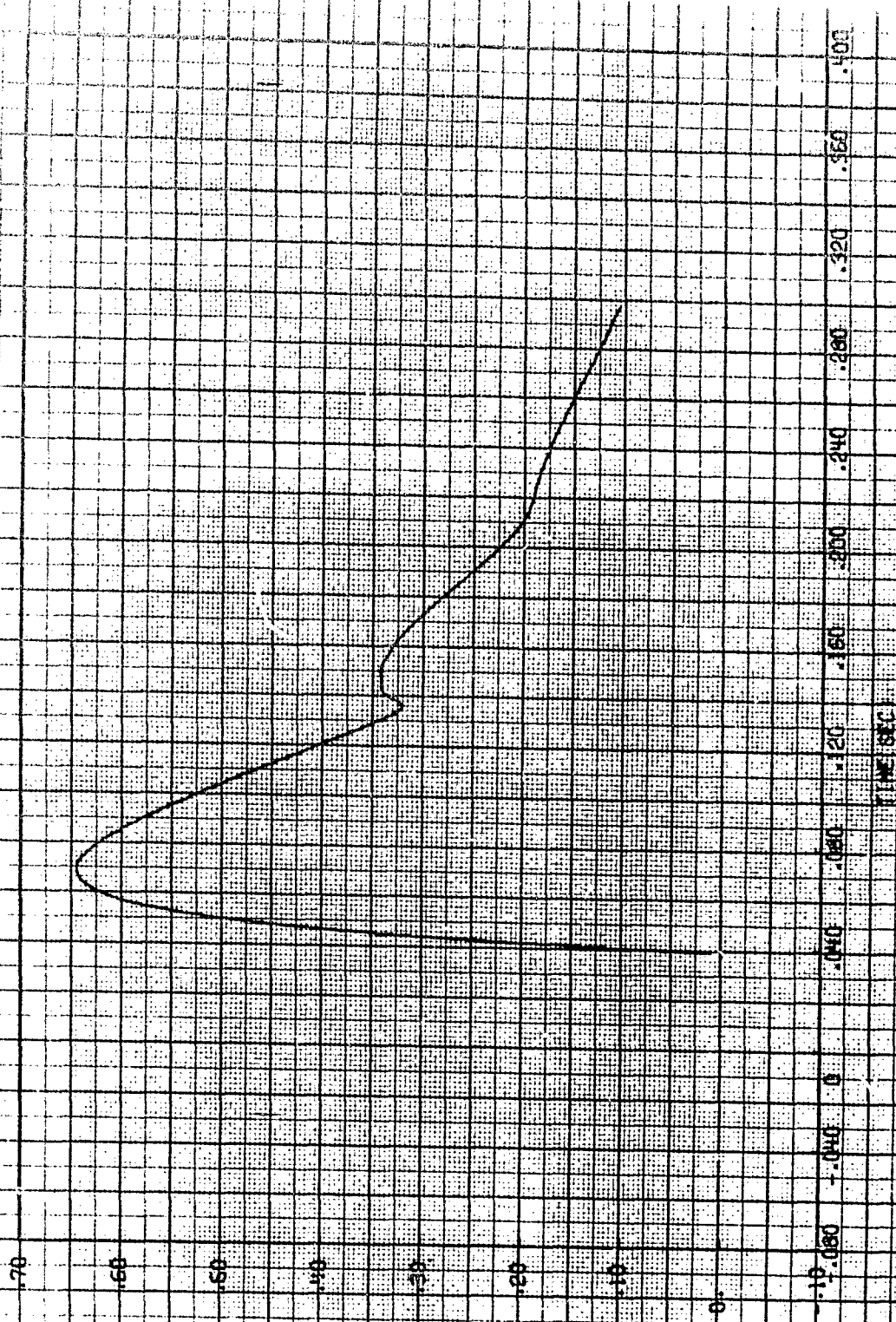




OVER PRESSURE VS TIME STATION NUMBER 5



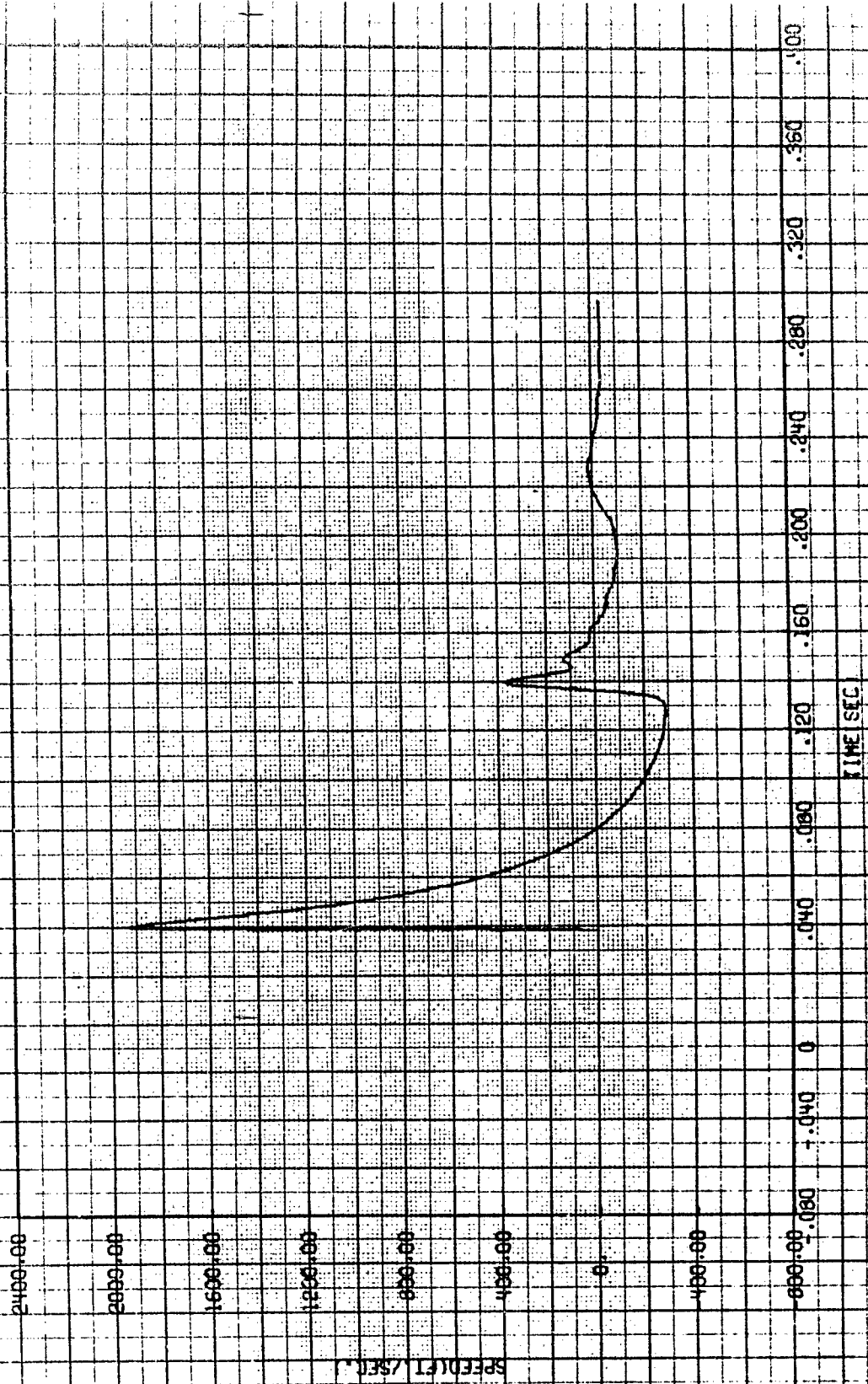
OVER PRESSURE IMPULSE VS TIME STATION NUMBER 5

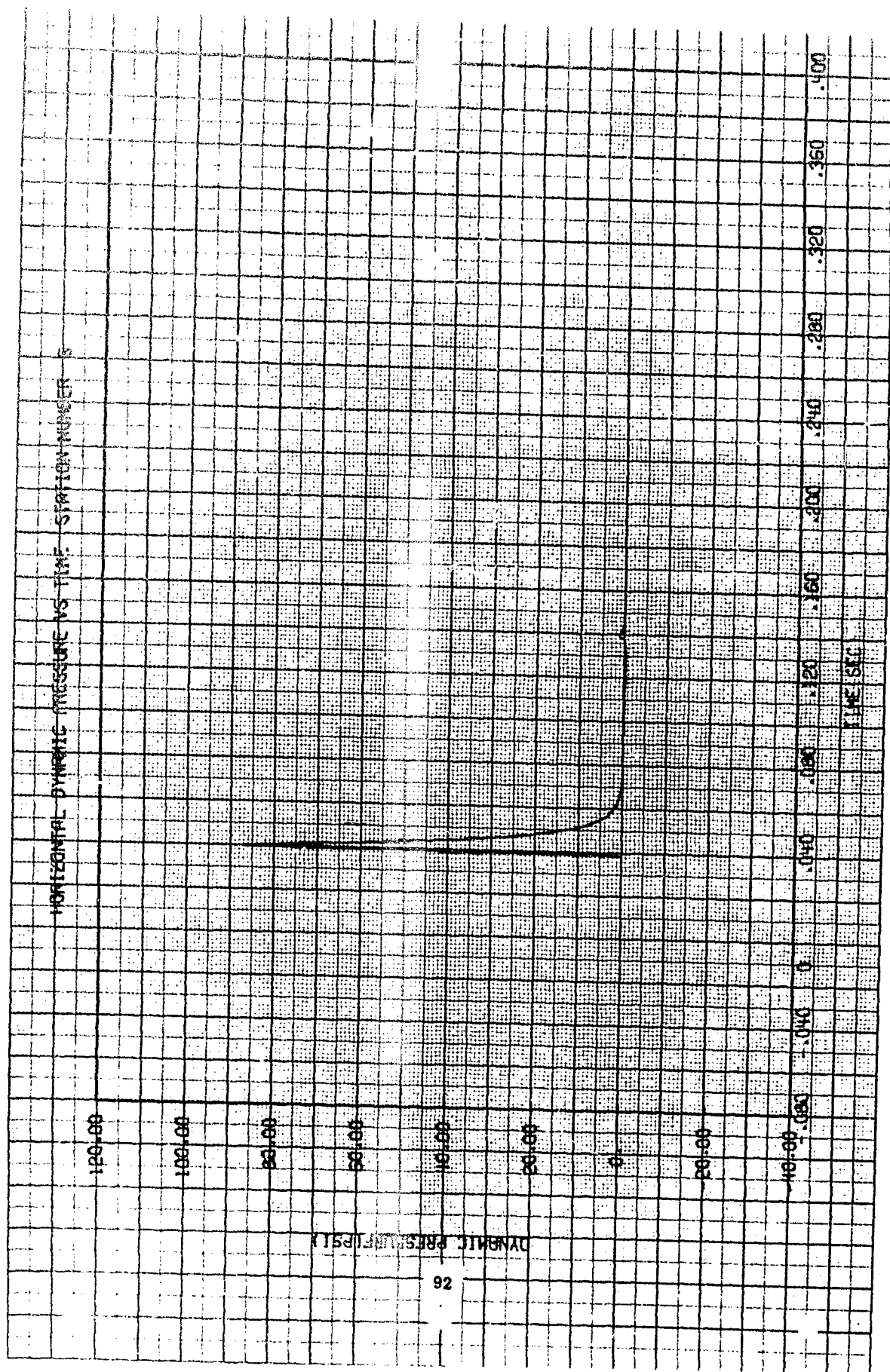


OVER PRESSURE IMPULSE (PSI)

06

HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 5





HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 5

.70

DYNAMIC PRESSURE IMPULSE (B. SEC.)

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-29.80

-29.90

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-30.50

-30.60

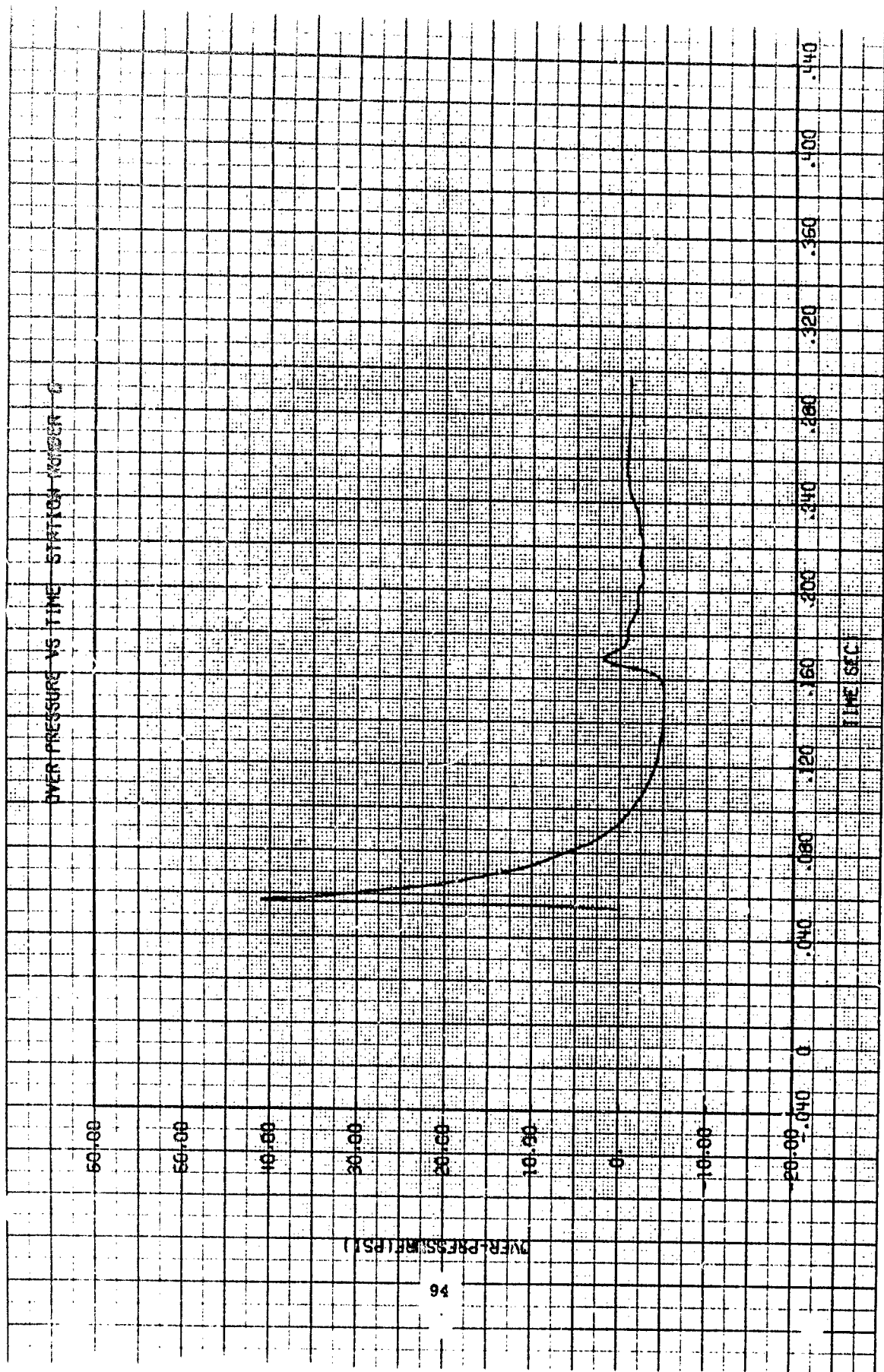
-30.70

-30.80

-30.90

-31.00

-31.10



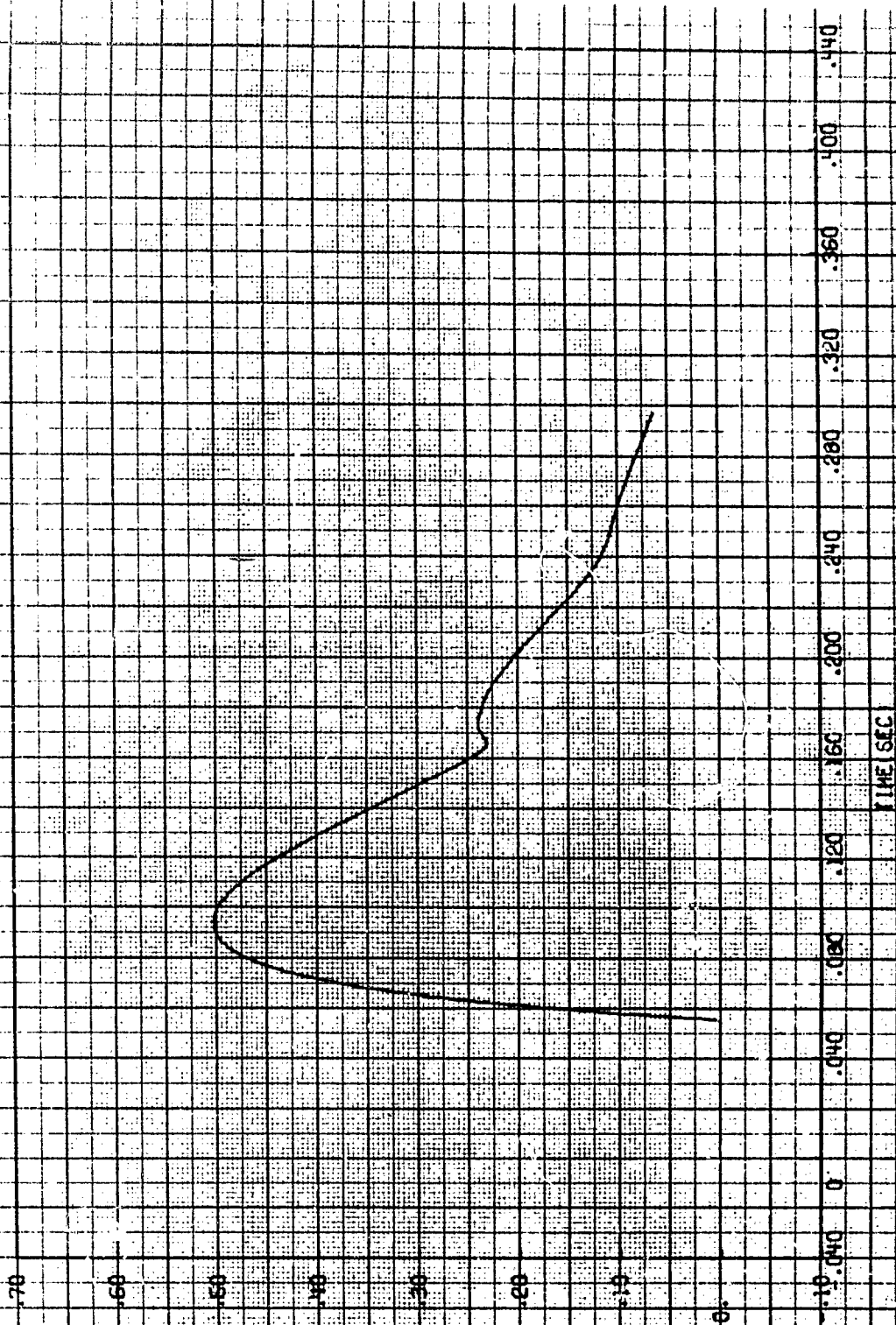
OVER PRESSURE (PSI)

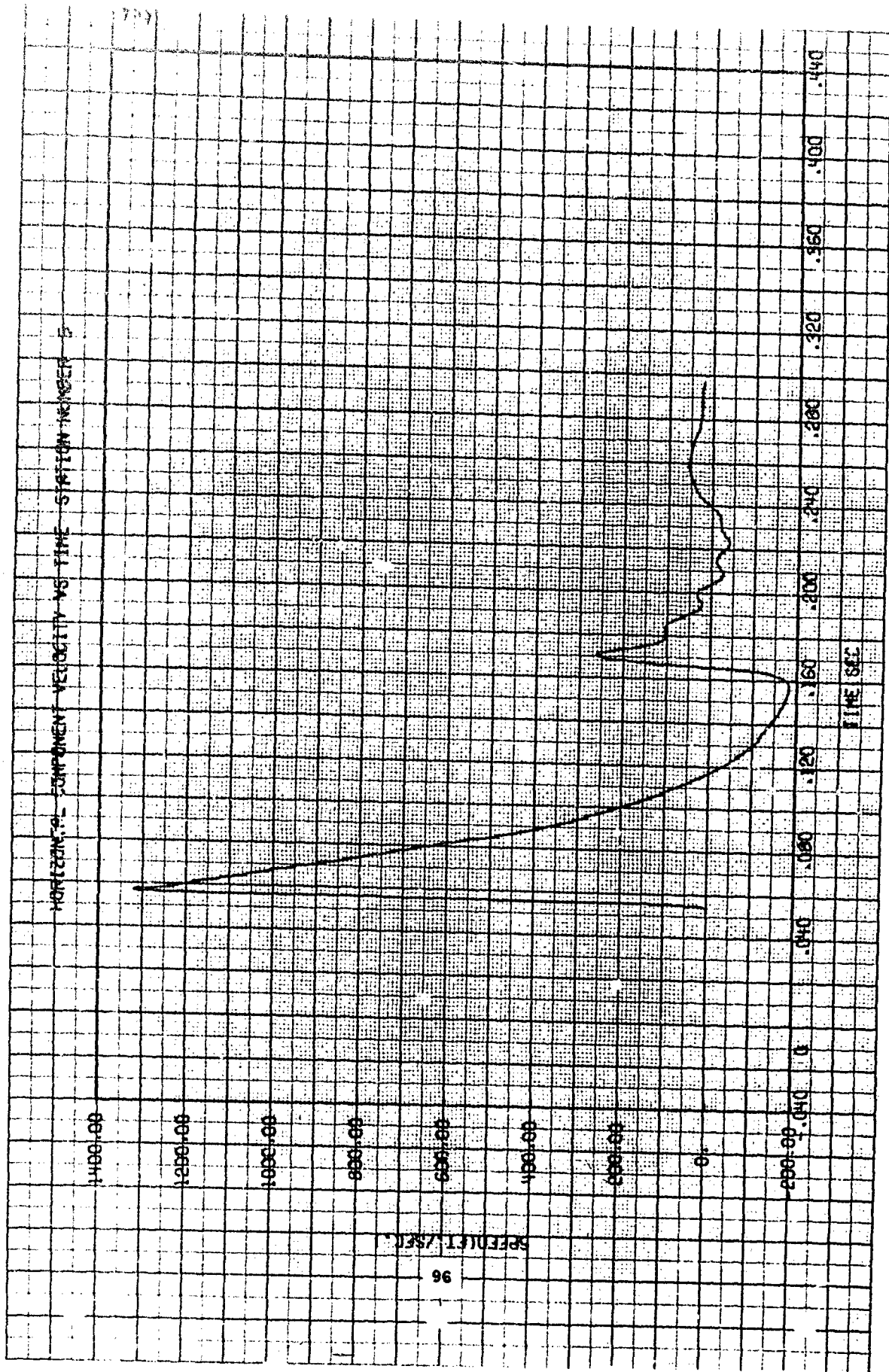
TIME (SEC)

OVER PRESSURE IMPULSE VS TIME STATION NUMBER 6

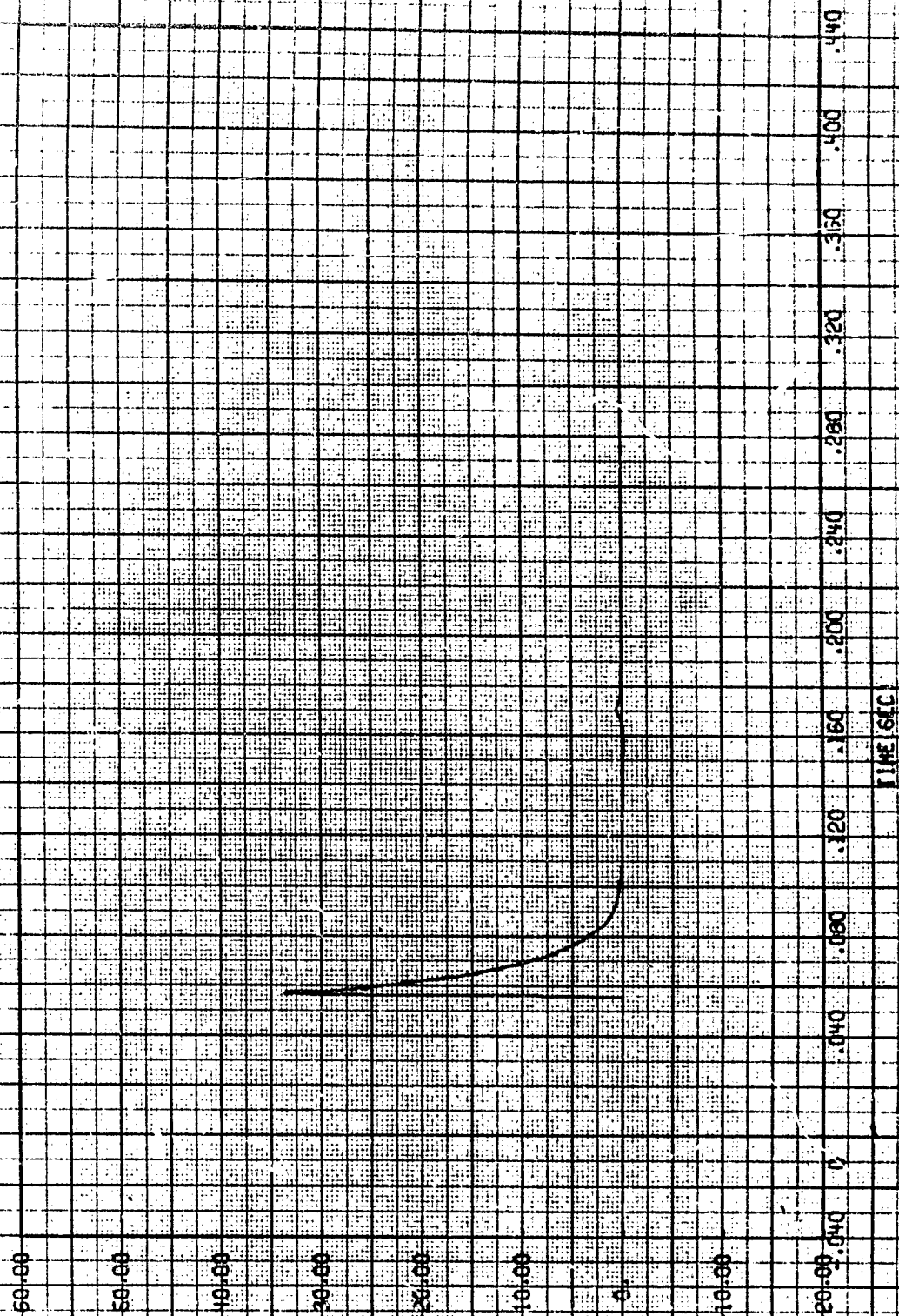
OVER PRESSURE IMPULSE LBS./SQ. IN.

95



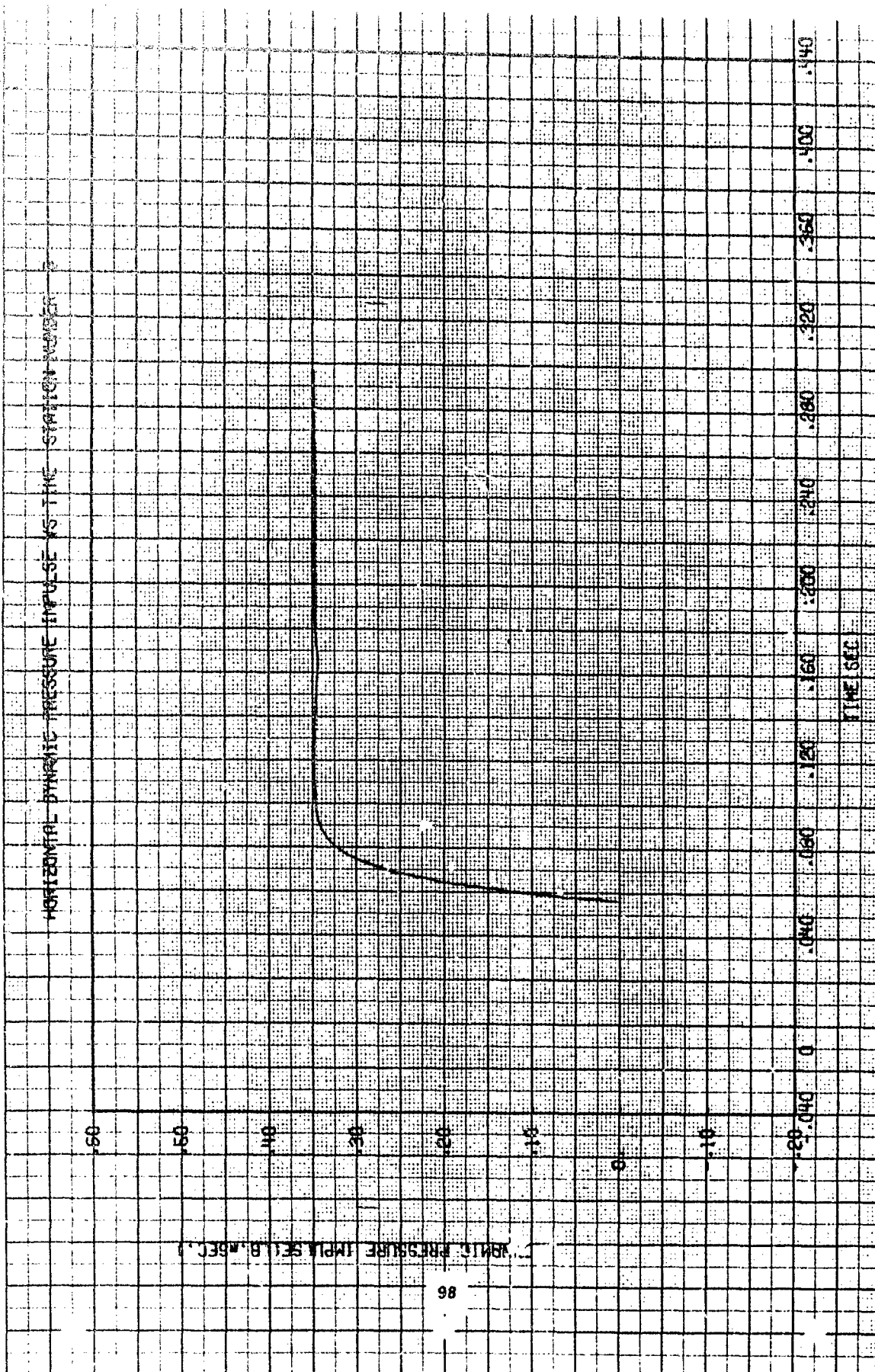


HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 5

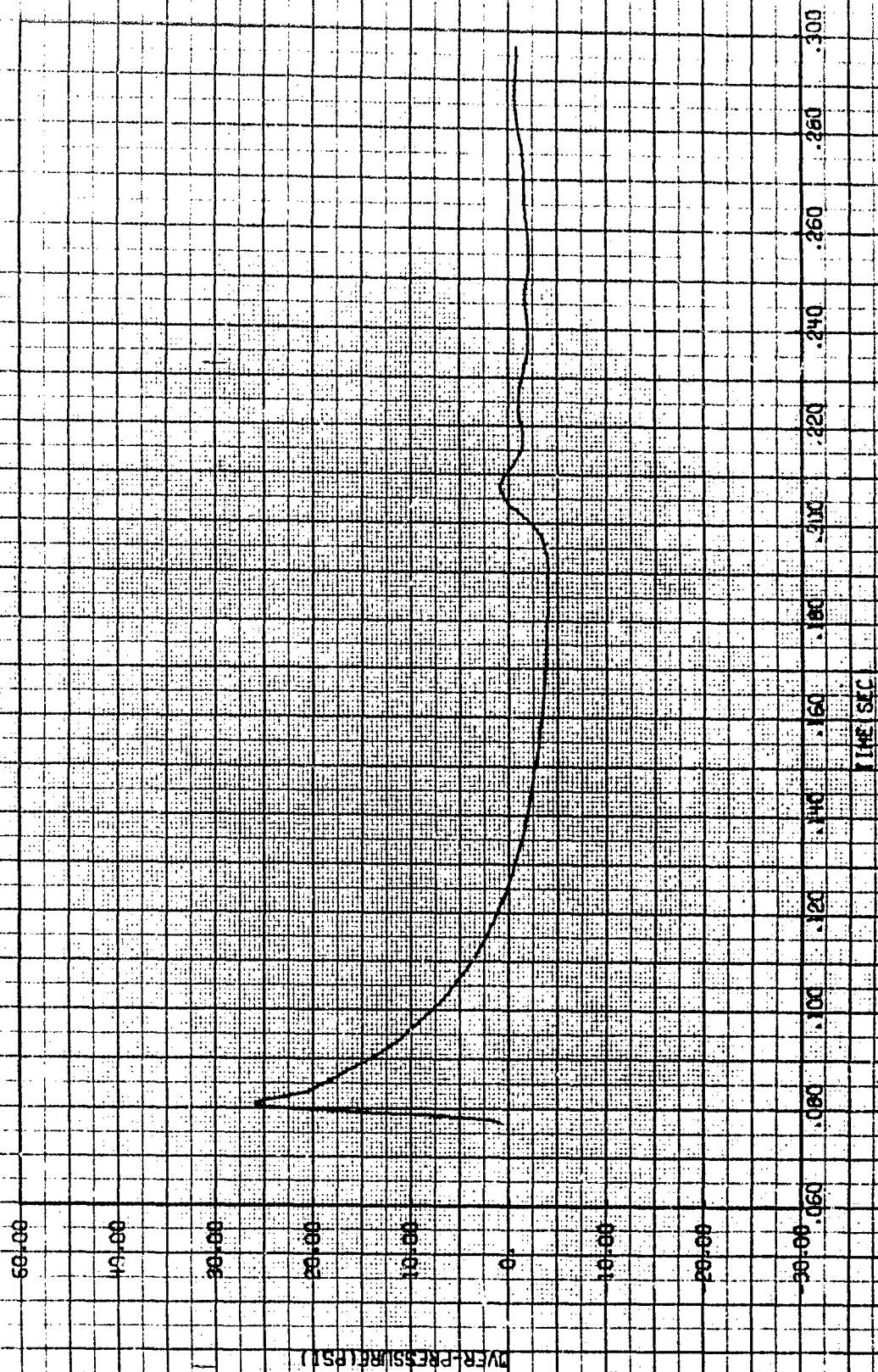


DYNAMIC PRESSURE (PSI)

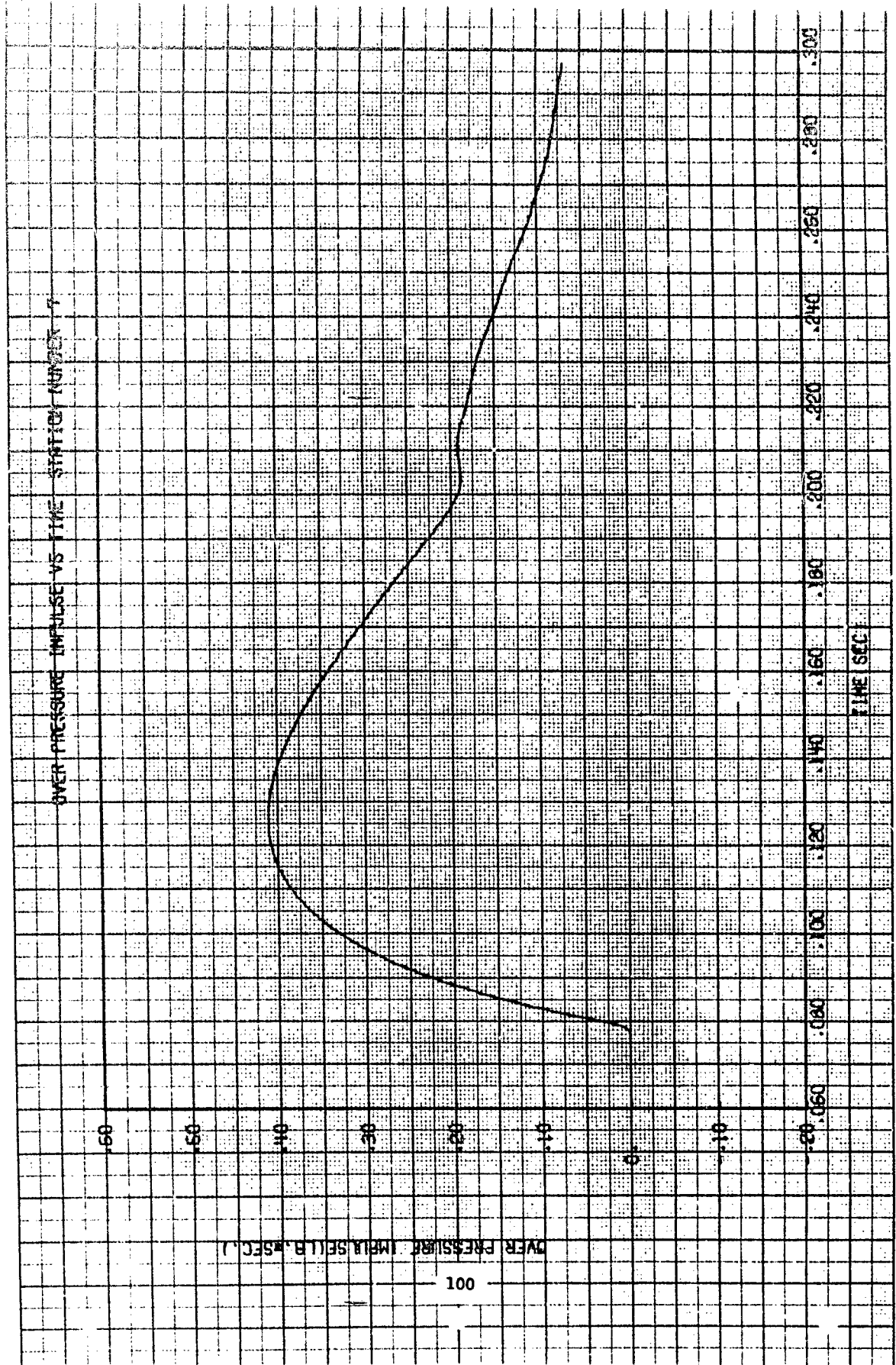
TIME (SEC)



OVER PRESSURE VS TIME STATION NUMBER 7



OVER PRESSURE IMPULSE VS TIME STATION NUMBER 7

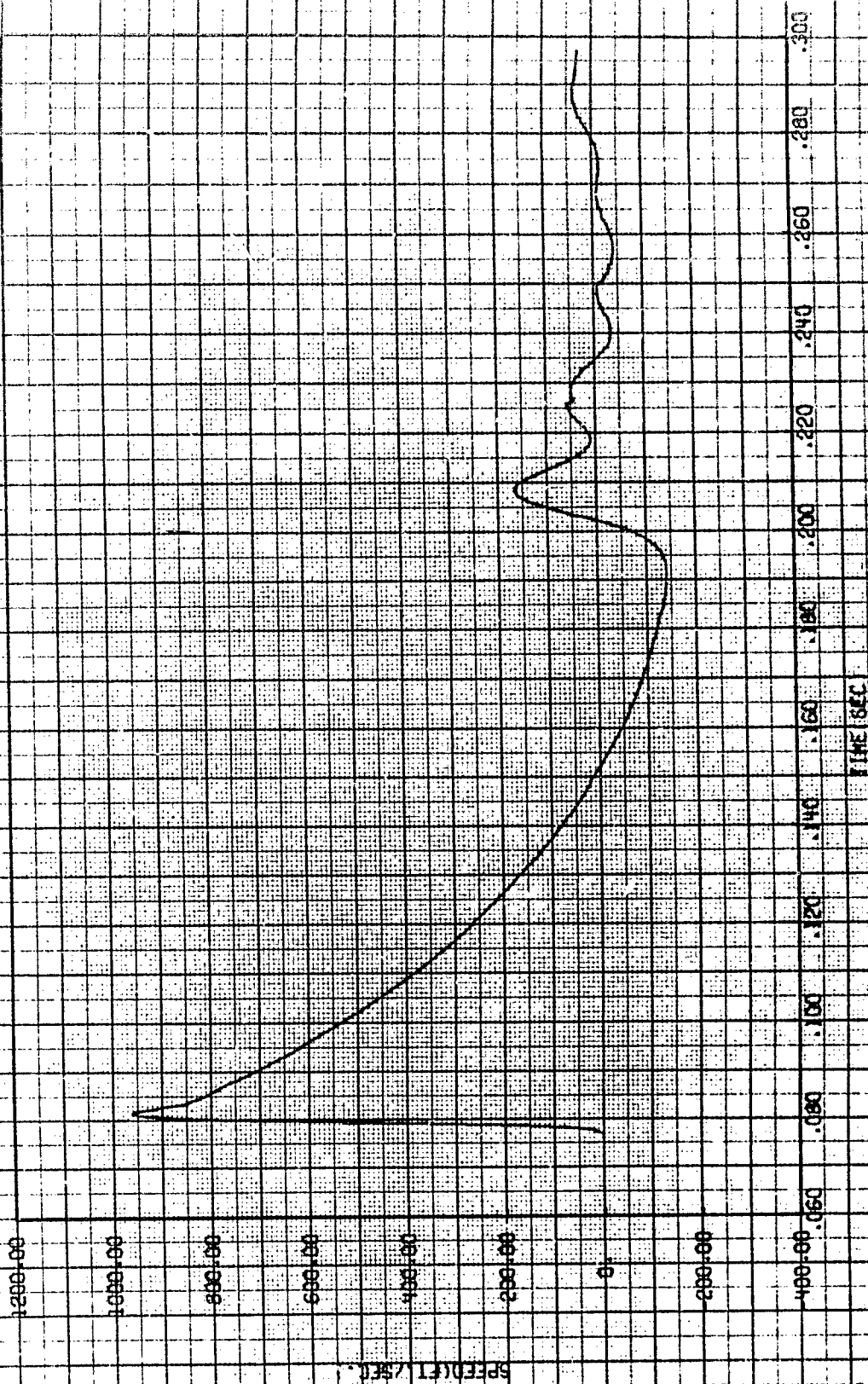


OVER PRESSURE IMPULSE (mbars*sec.)

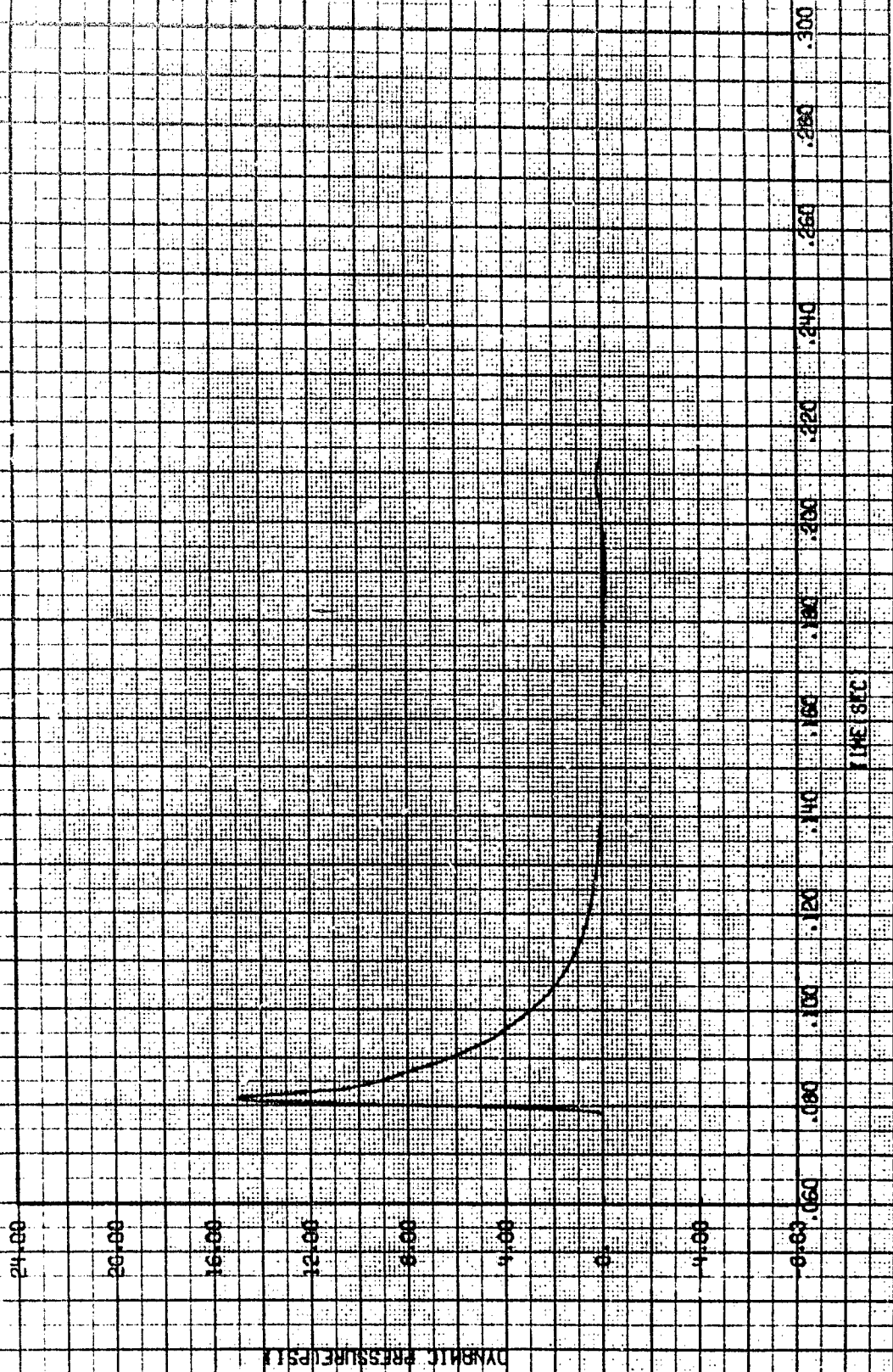
100

TIME (SEC)

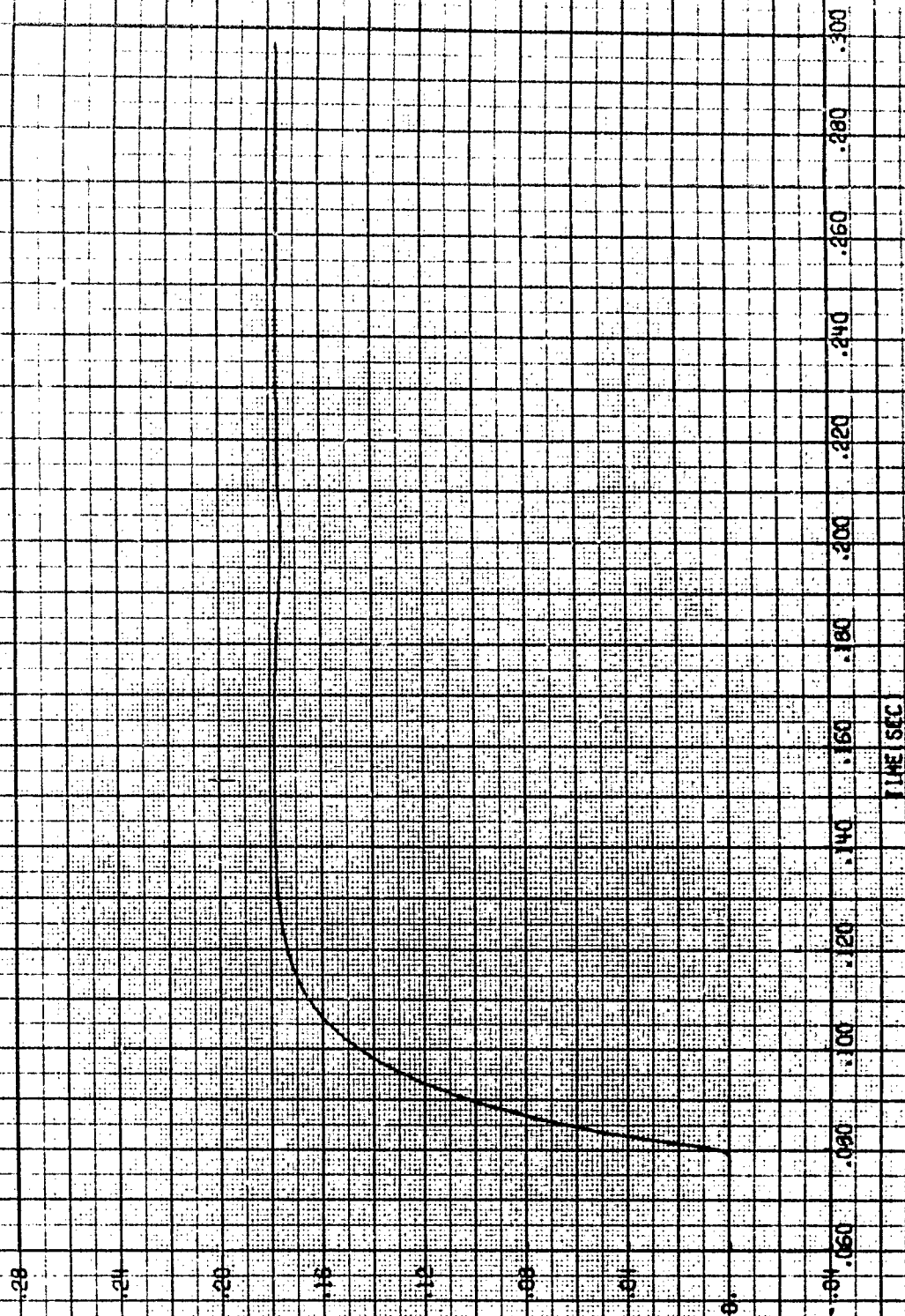
HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 7



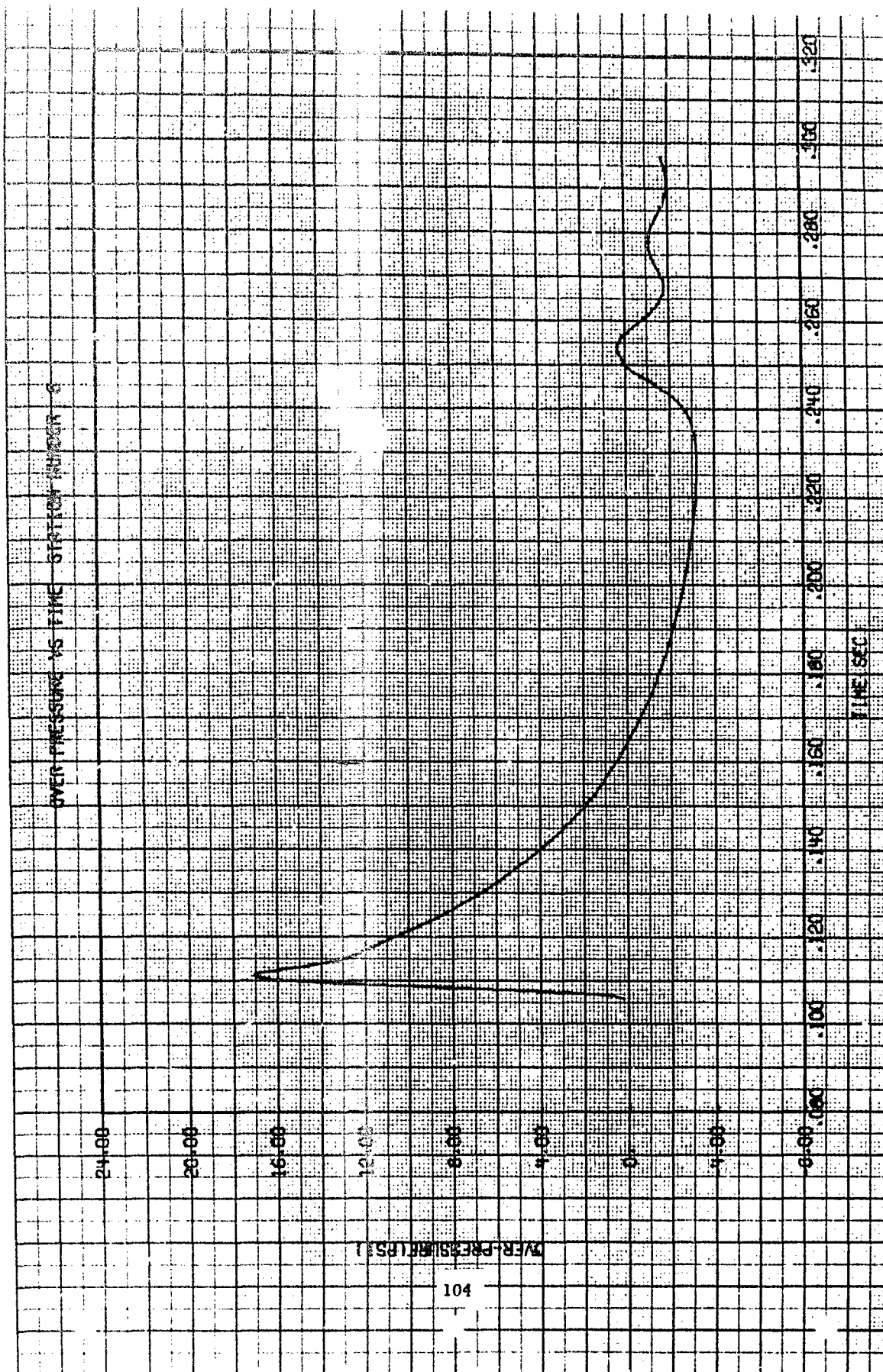
HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 7



HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 7

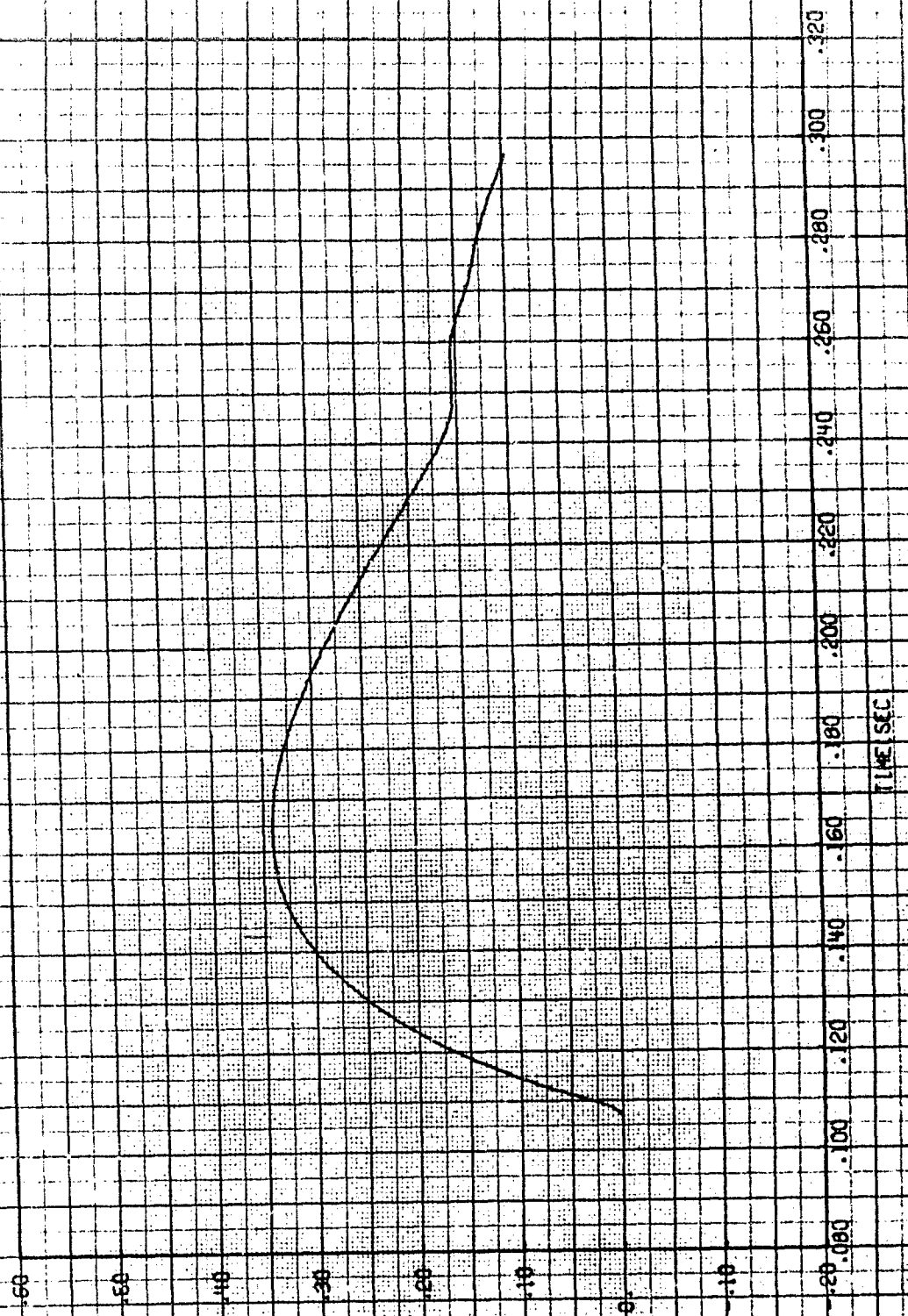


DYNAMIC PRESSURE IMPULSE (LBS. / SQ. IN. SEC.)



OVER-PRESSURE (PSI)

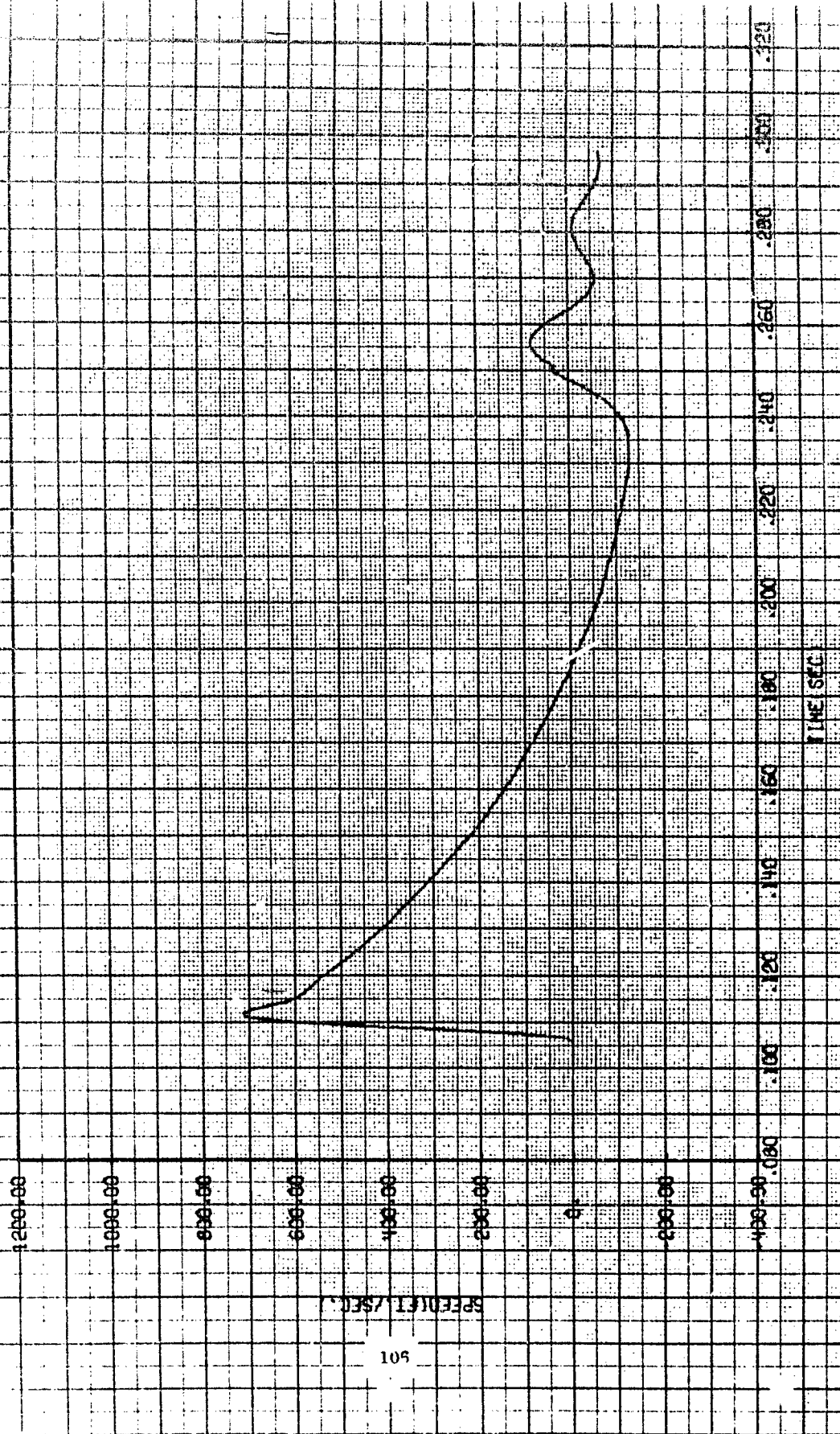
OVER PRESSURE IMPULSE VS TIME STATION NUMBER 8



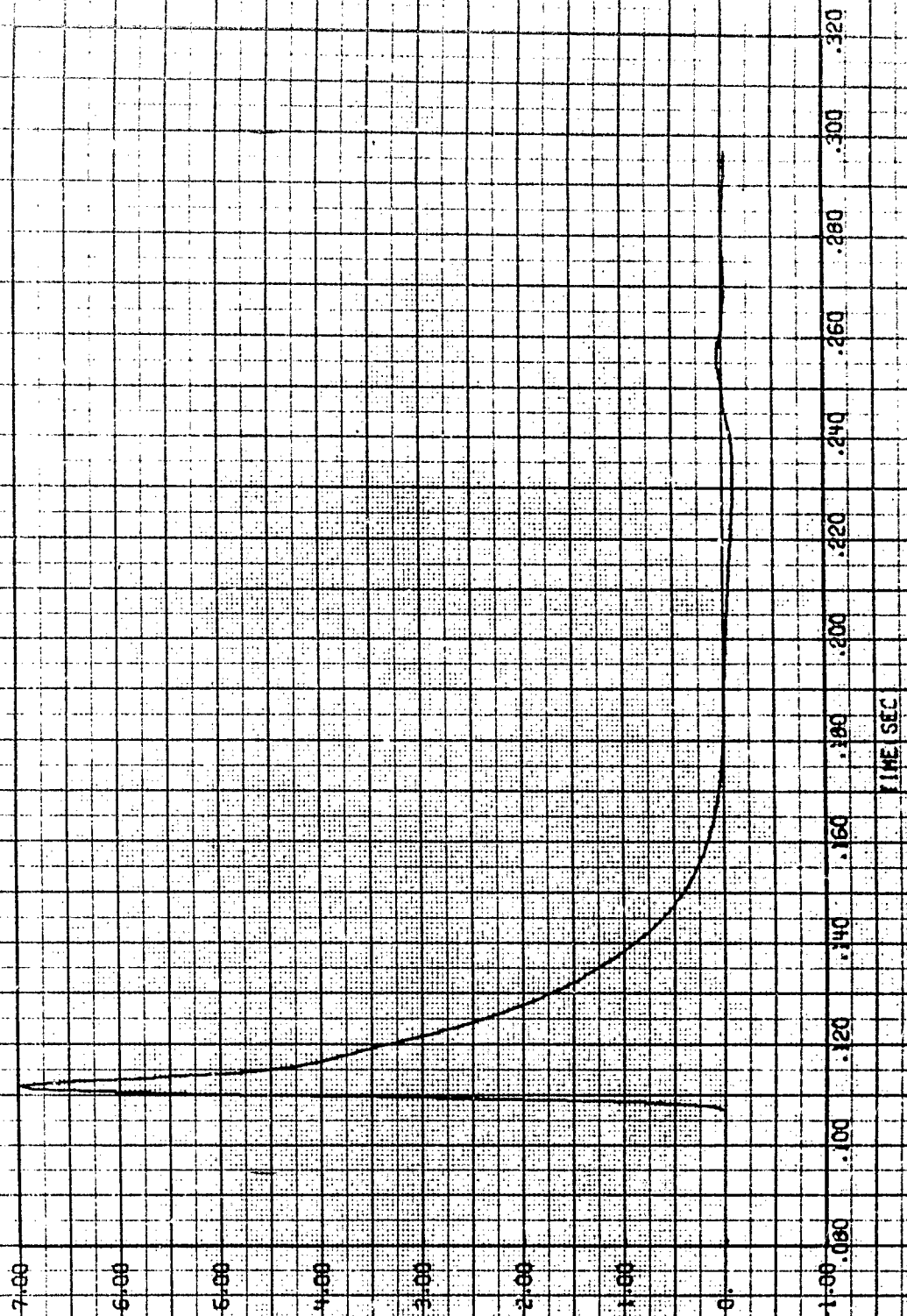
OVER PRESSURE IMPULSE (LBS./SQ. IN. SEC.)

TIME (SEC.)

HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 9



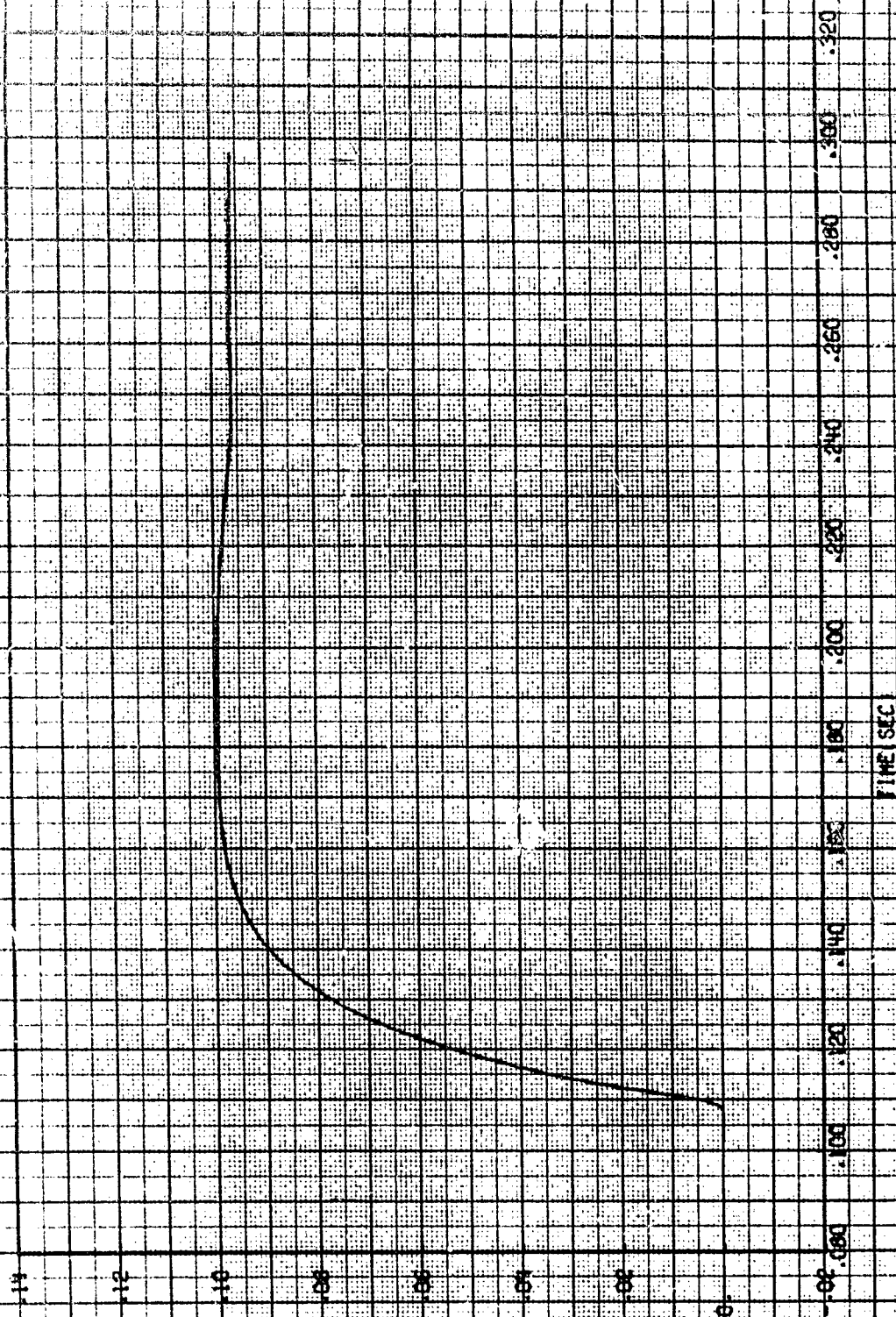
HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 3



DYNAMIC PRESSURE (PSI)

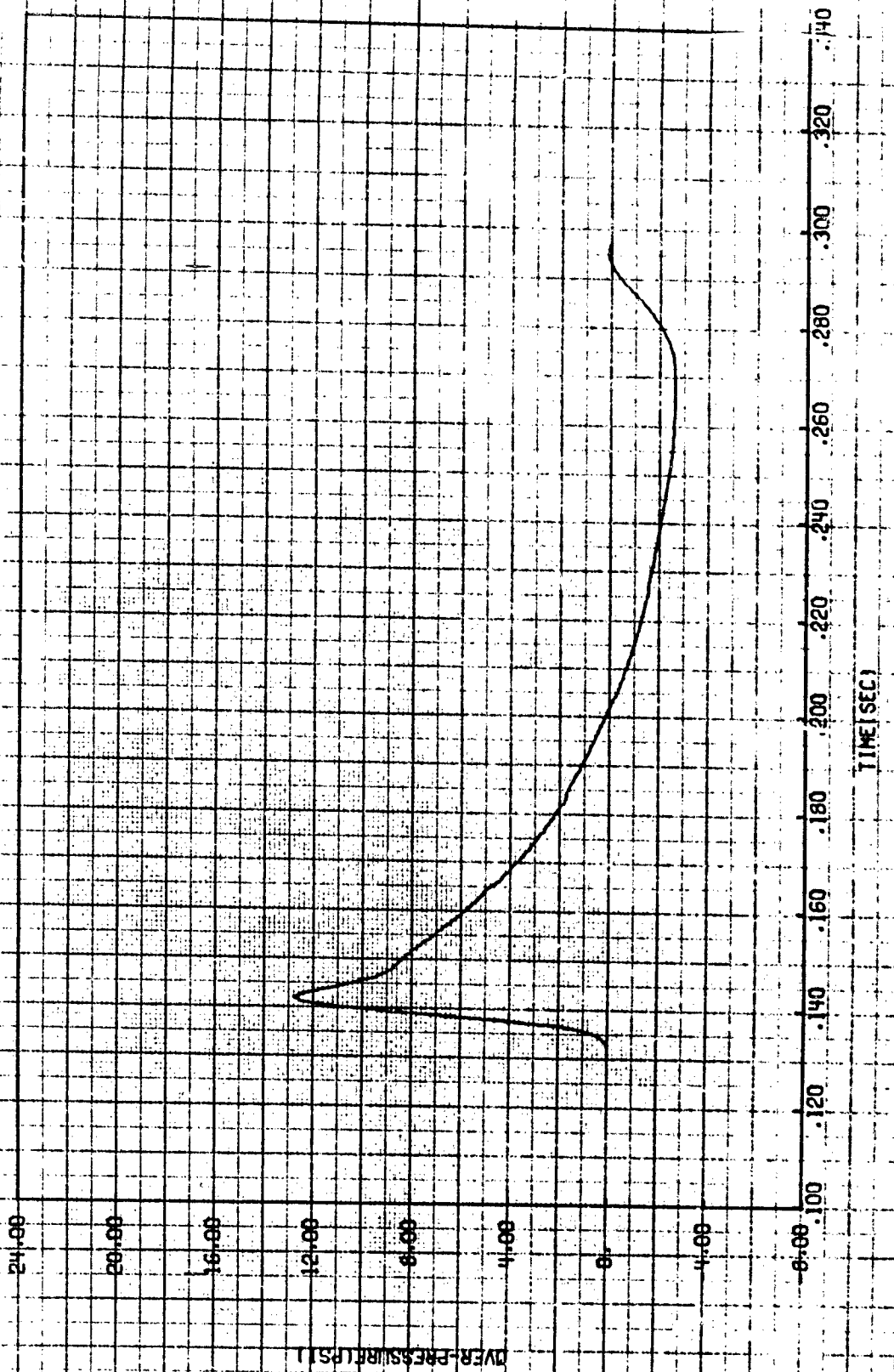
TIME SEC

HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 3

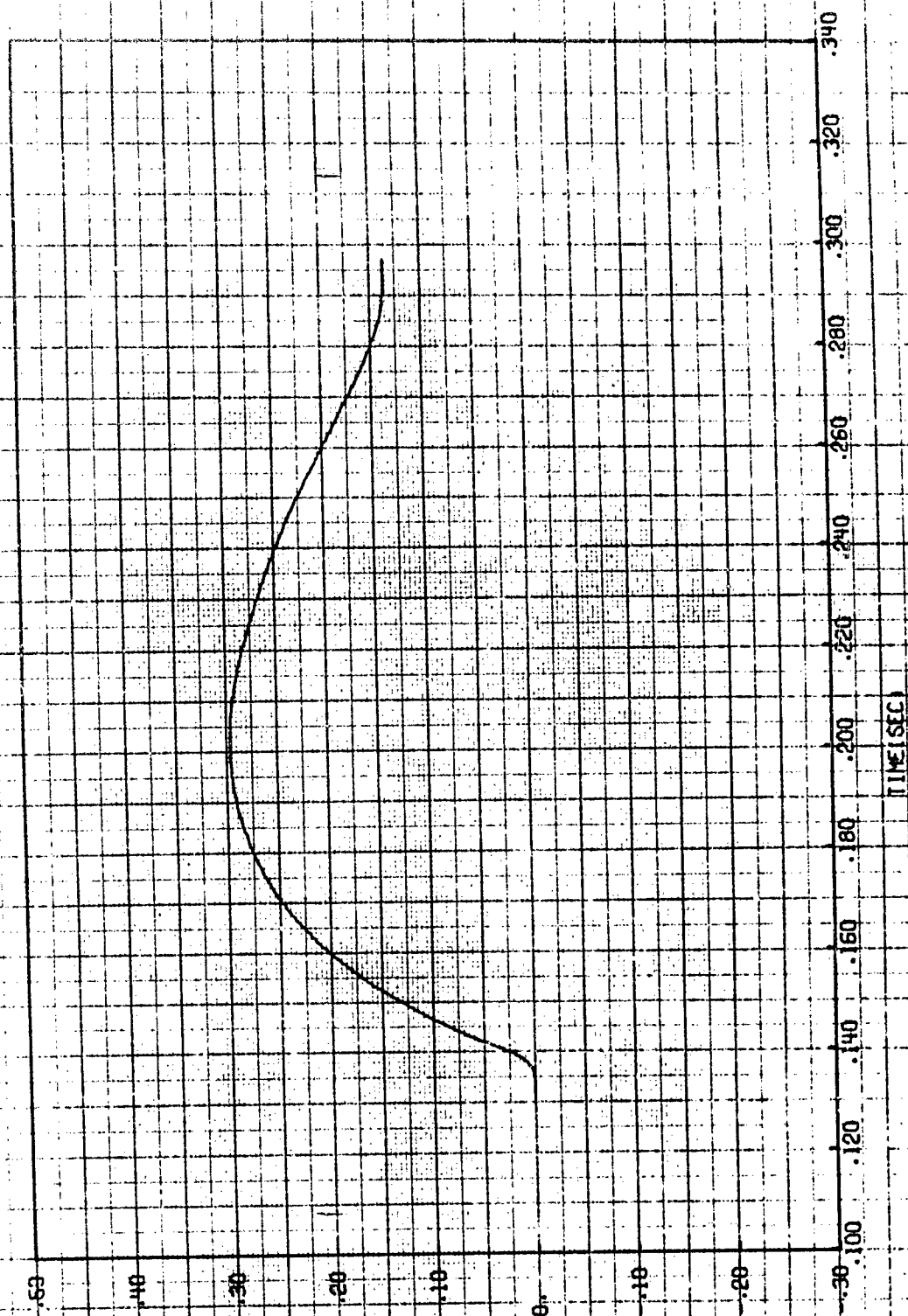


DYNAMIC PRESSURE (LBS/IN.²) SEC.

OVER PRESSURE VS TIME STATION NUMBER 9

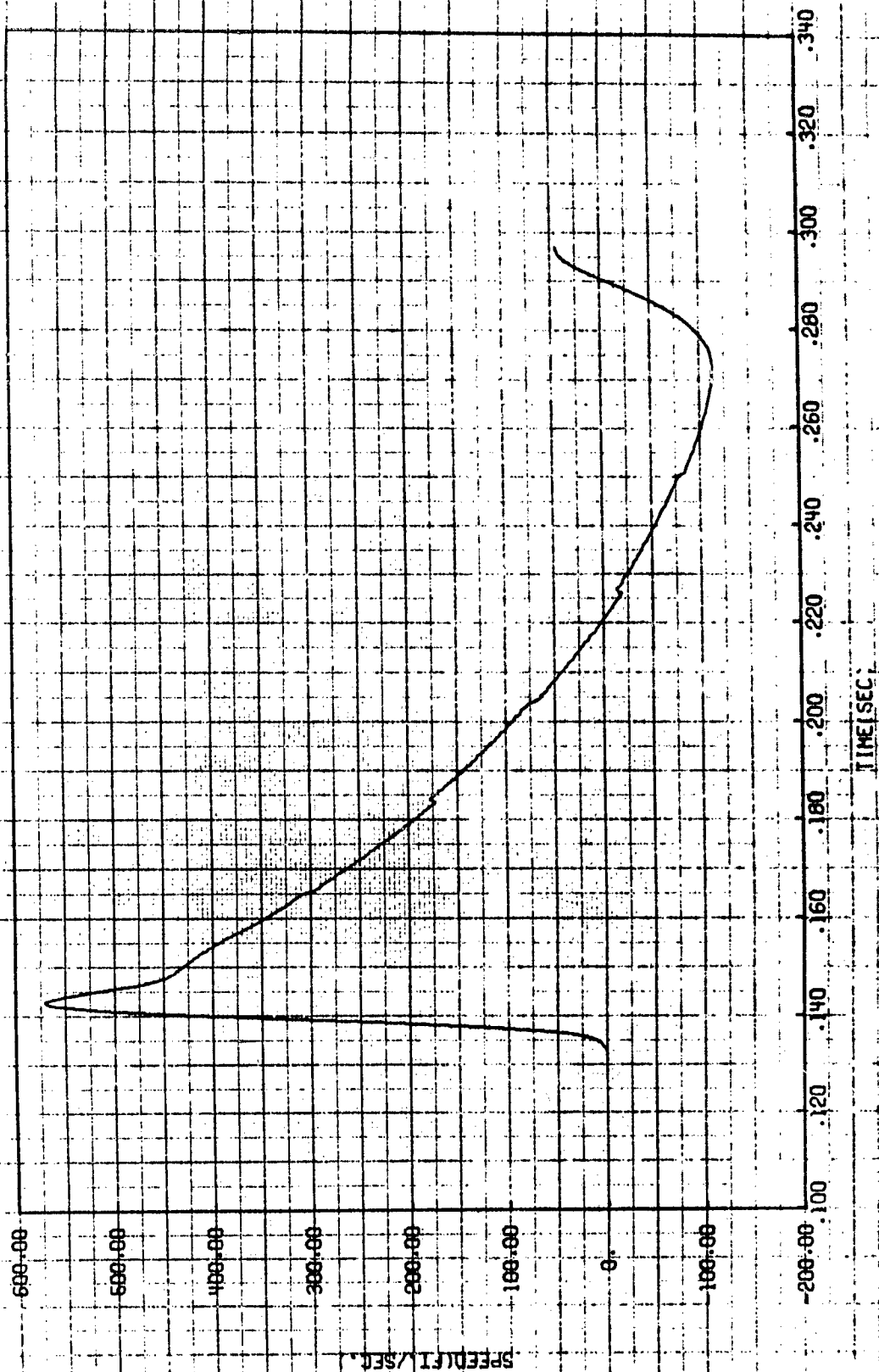


OVER PRESSURE IMPULSE VS TIME STATION NUMBER 9

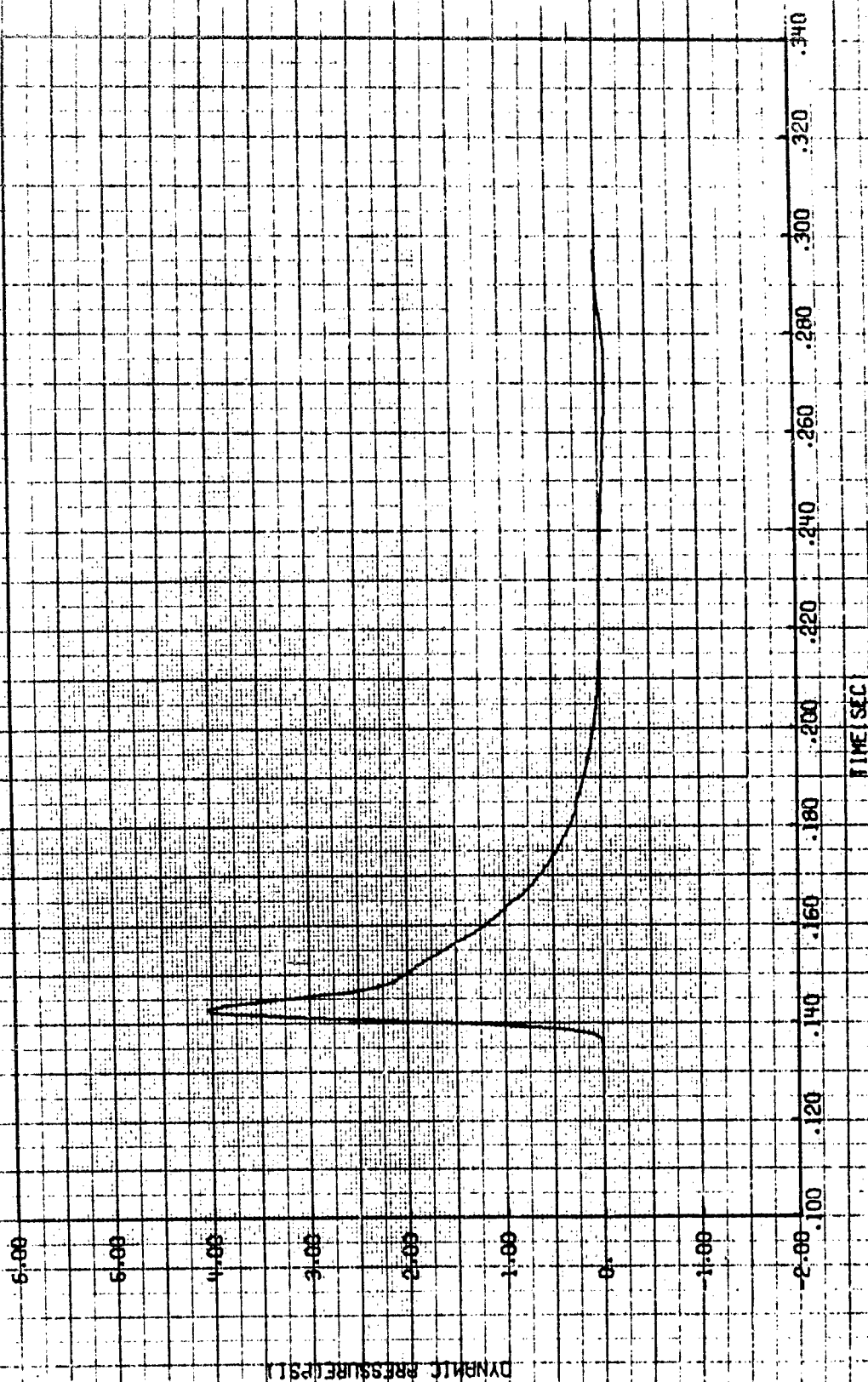


OVER PRESSURE IMPULSE (LB. SEC.)

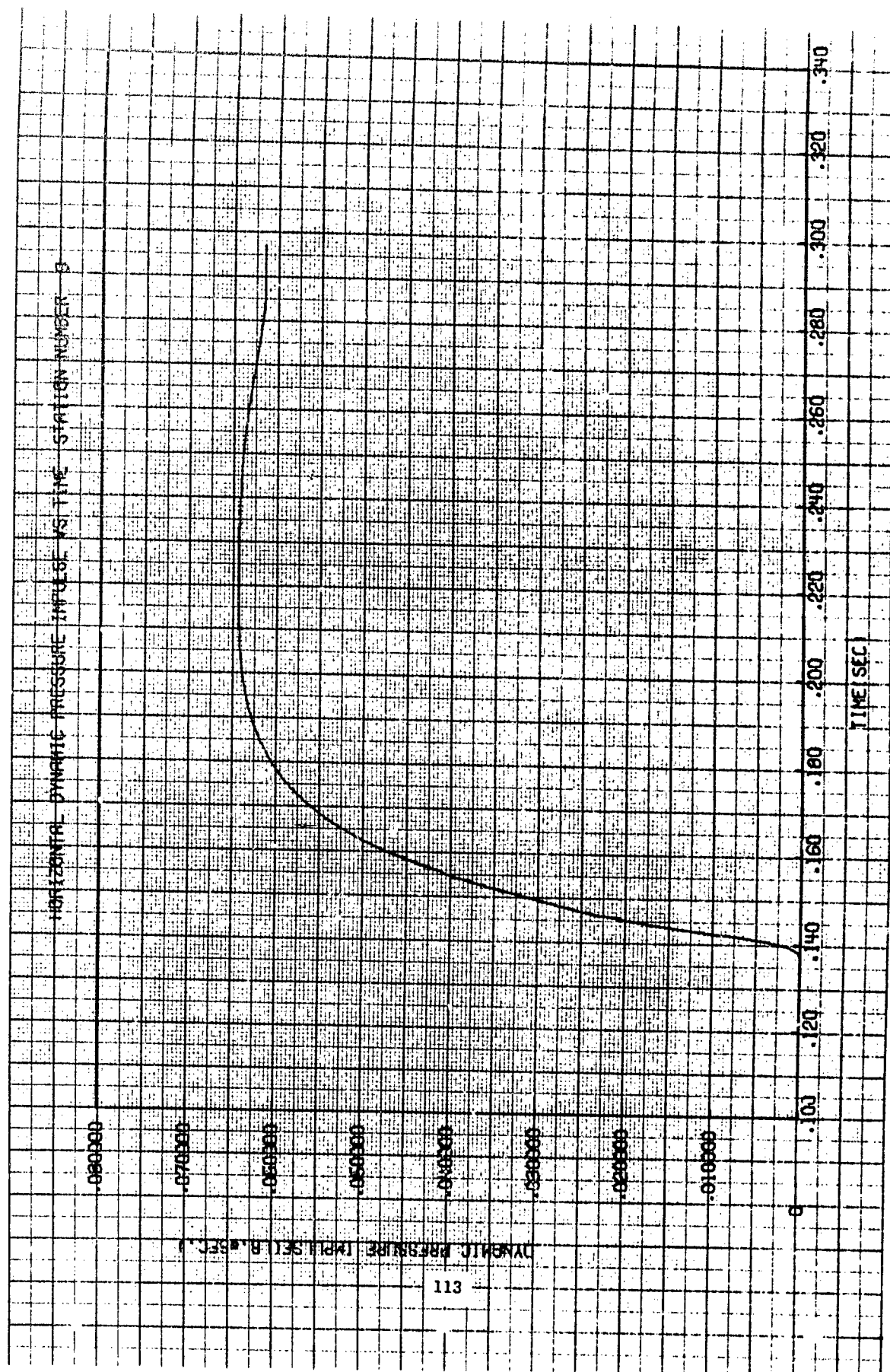
HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 9



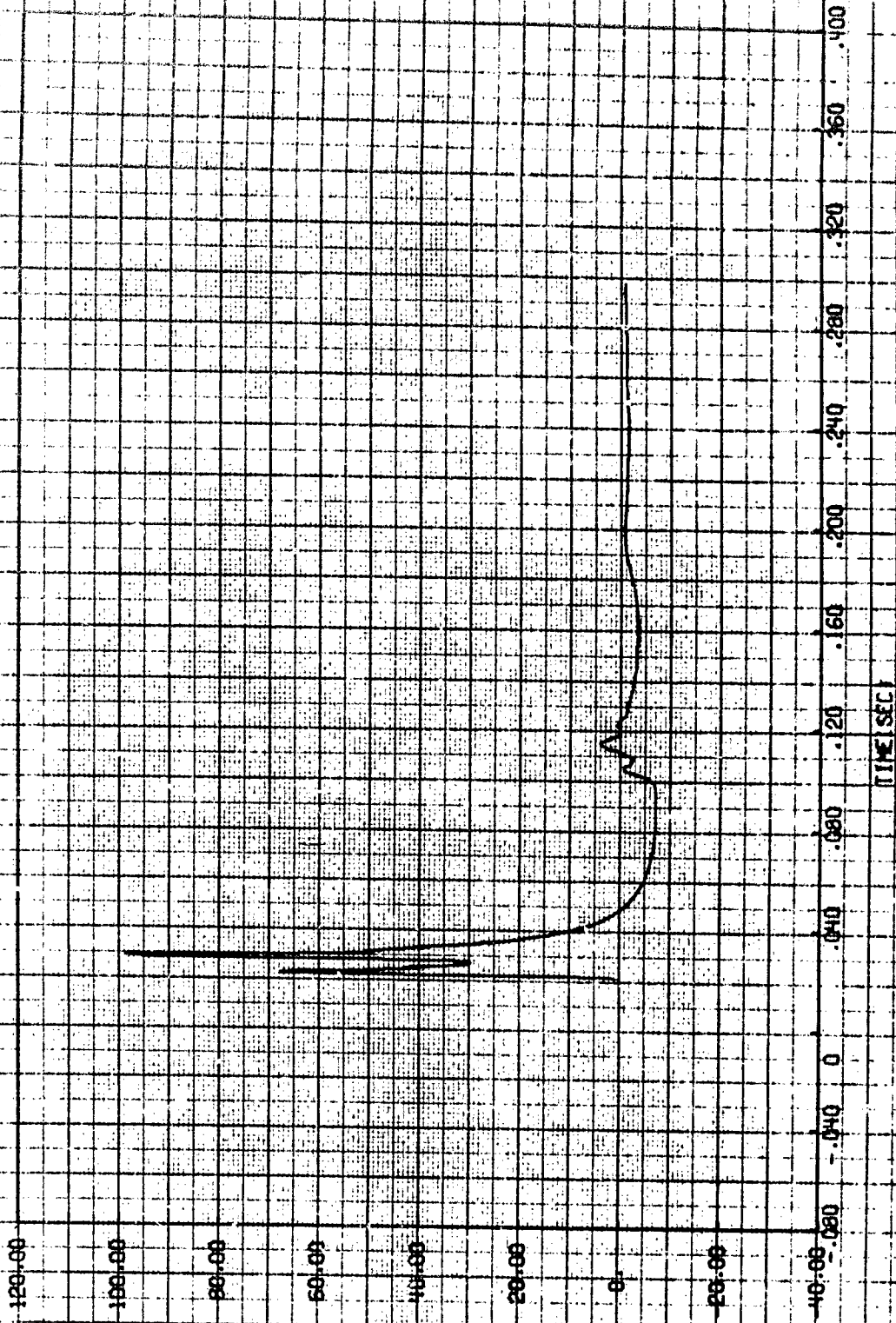
HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 9



DYNAMIC PRESSURE (PSI)



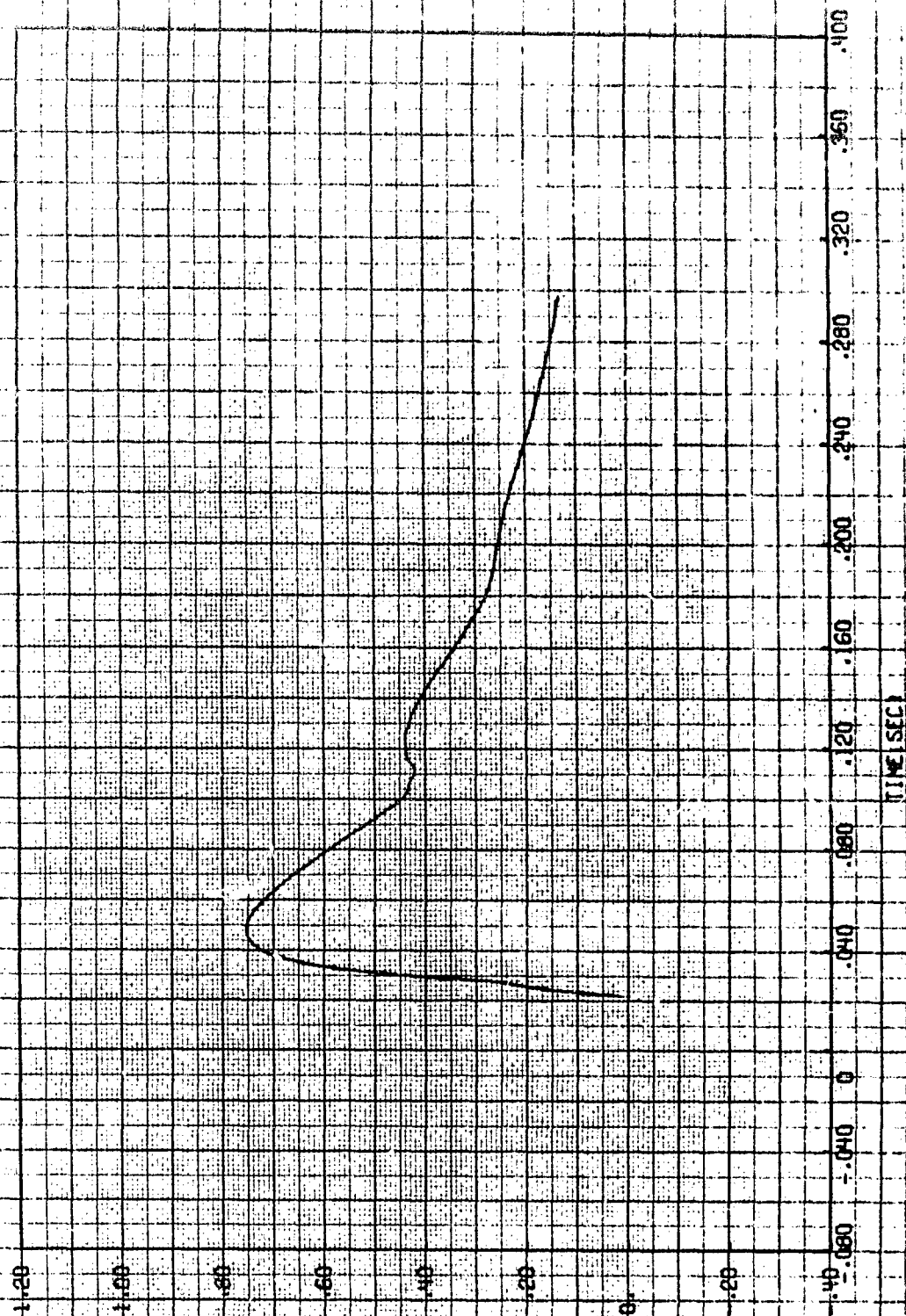
OVER PRESSURE VS TIME STATION NUMBER 10



OVER PRESSURE (PSI)

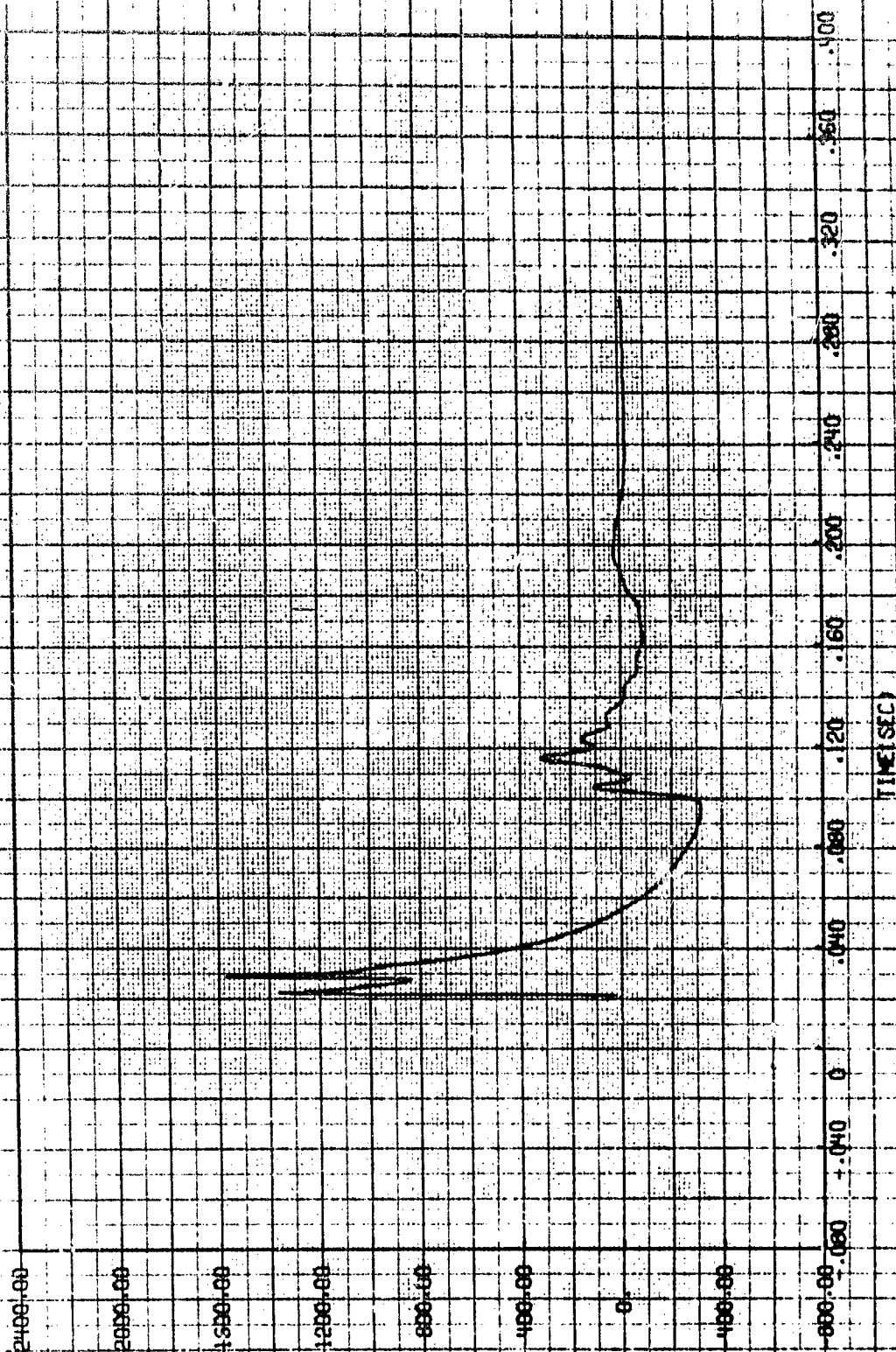
TIME (SEC)

OVER PRESSURE INFUSE VS TIME STATION NUMBER 10



OVER PRESSURE INFUSE (MBAR SEILR, -SEC.)

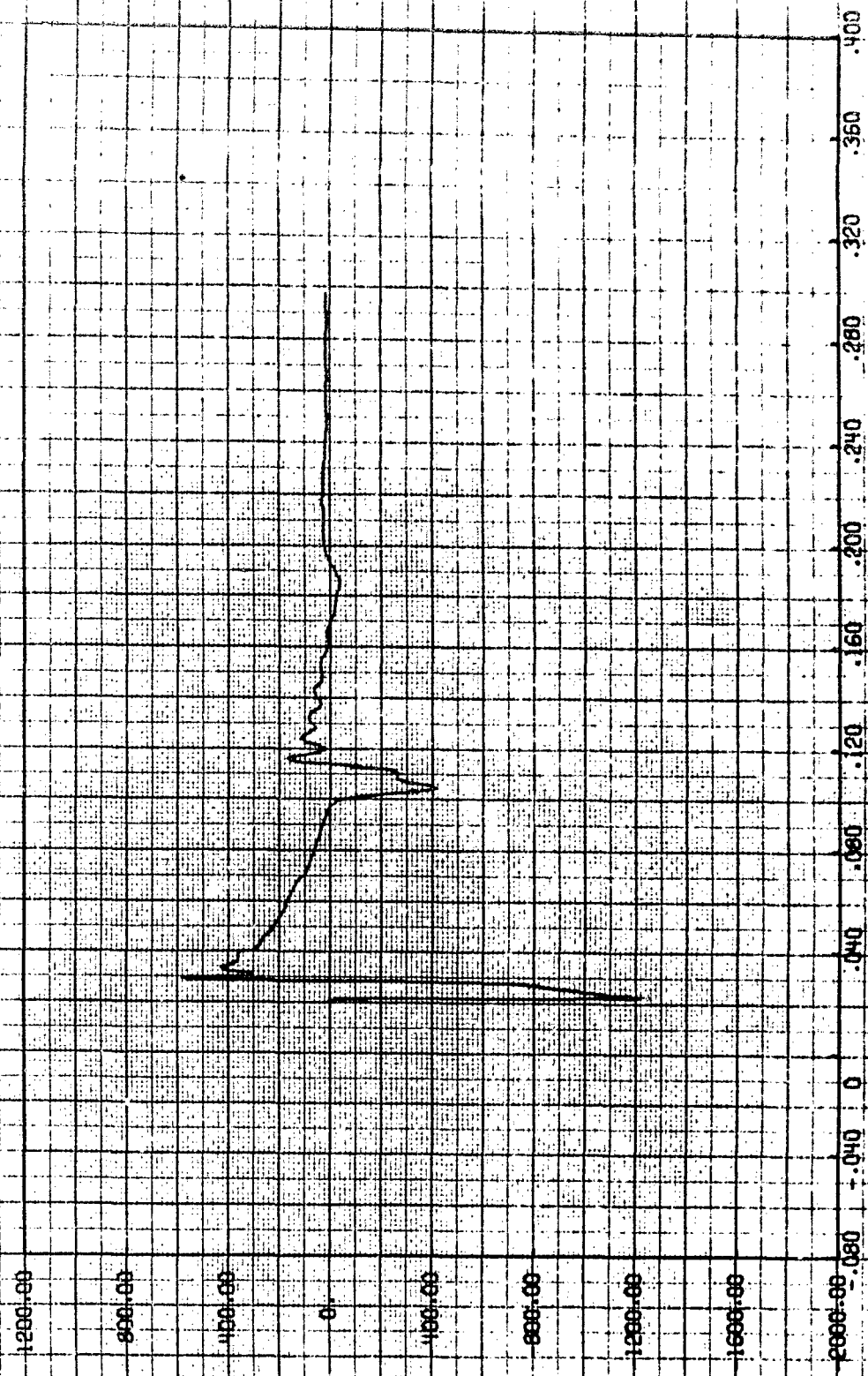
HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 10



SPEED (FT./SEC.)

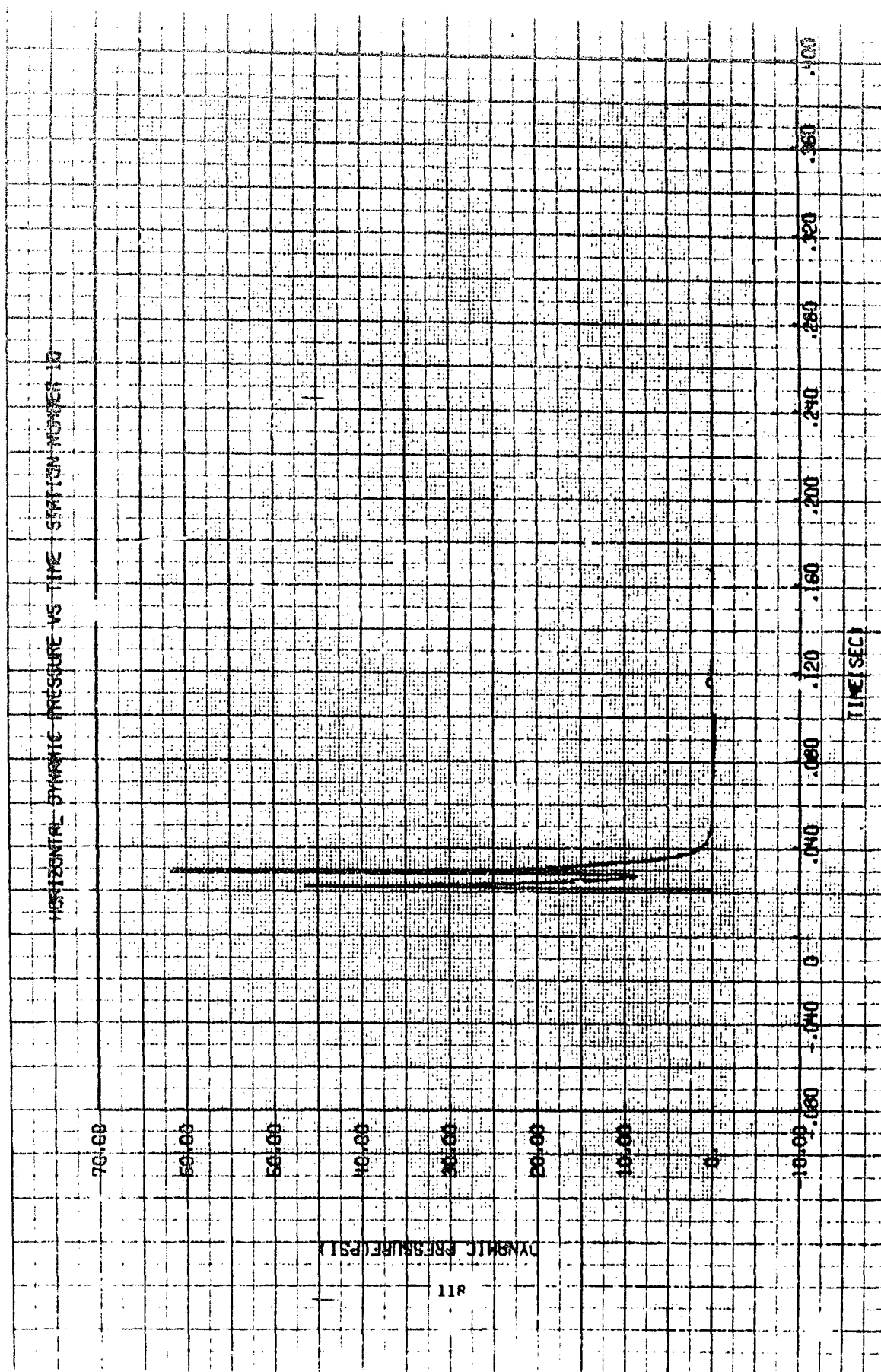
TIME (SEC.)

VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 10

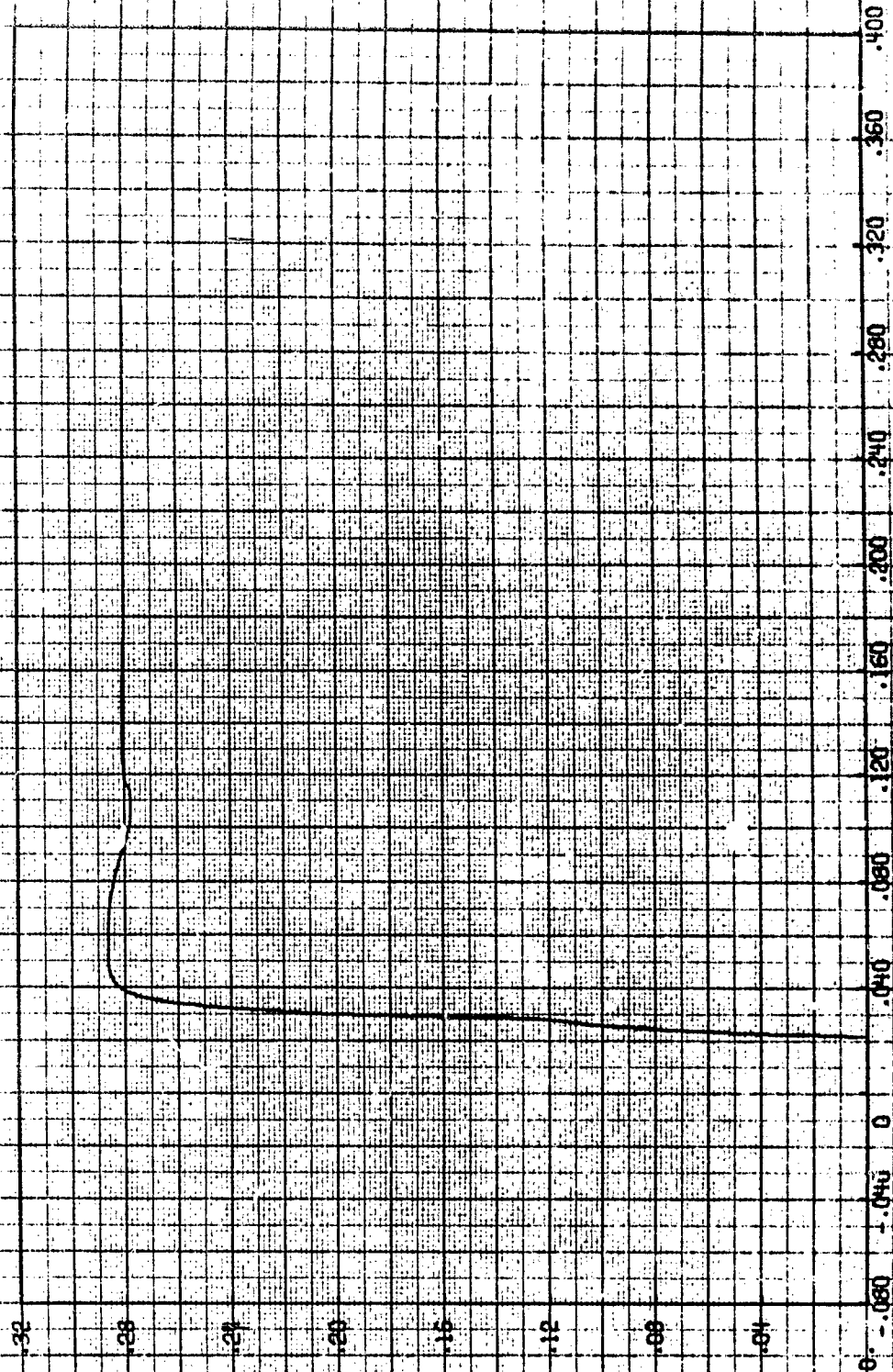


SPEED (FT./SEC.)

TIME (SEC.)



HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 10



119

VERTICAL DYNAMIC PRESSURE VS TIME STATION NUMBER 10

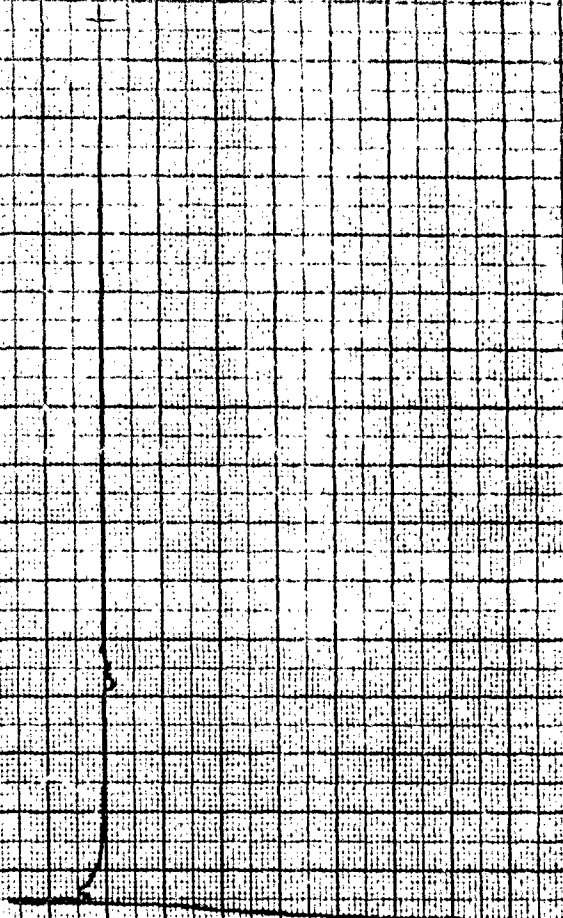
DYNAMIC PRESSURE (PSI)

120

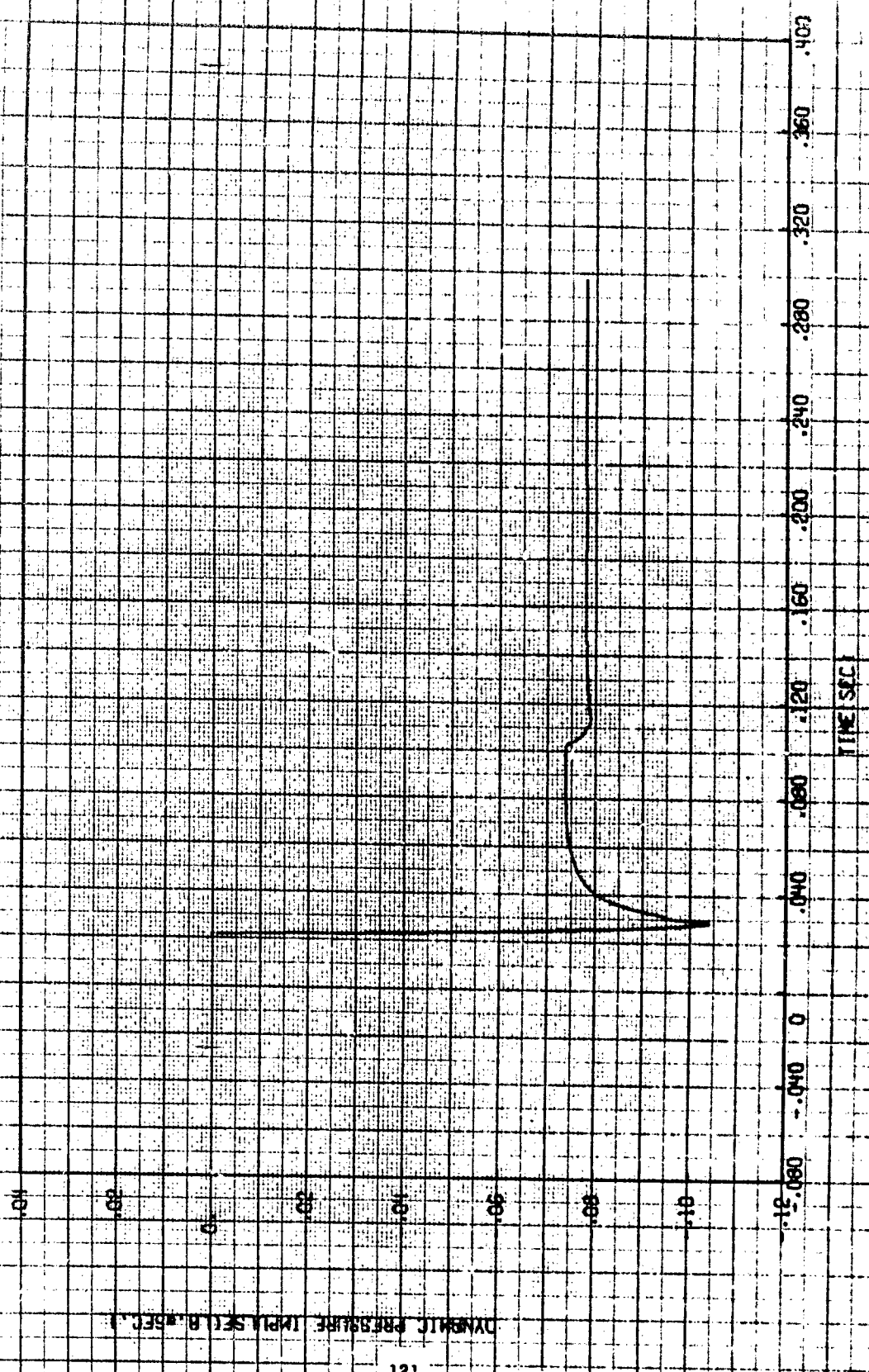
30.00
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0.000 0.040 0.080 0.120 0.160 0.200 0.240 0.280 0.320 0.360 0.400

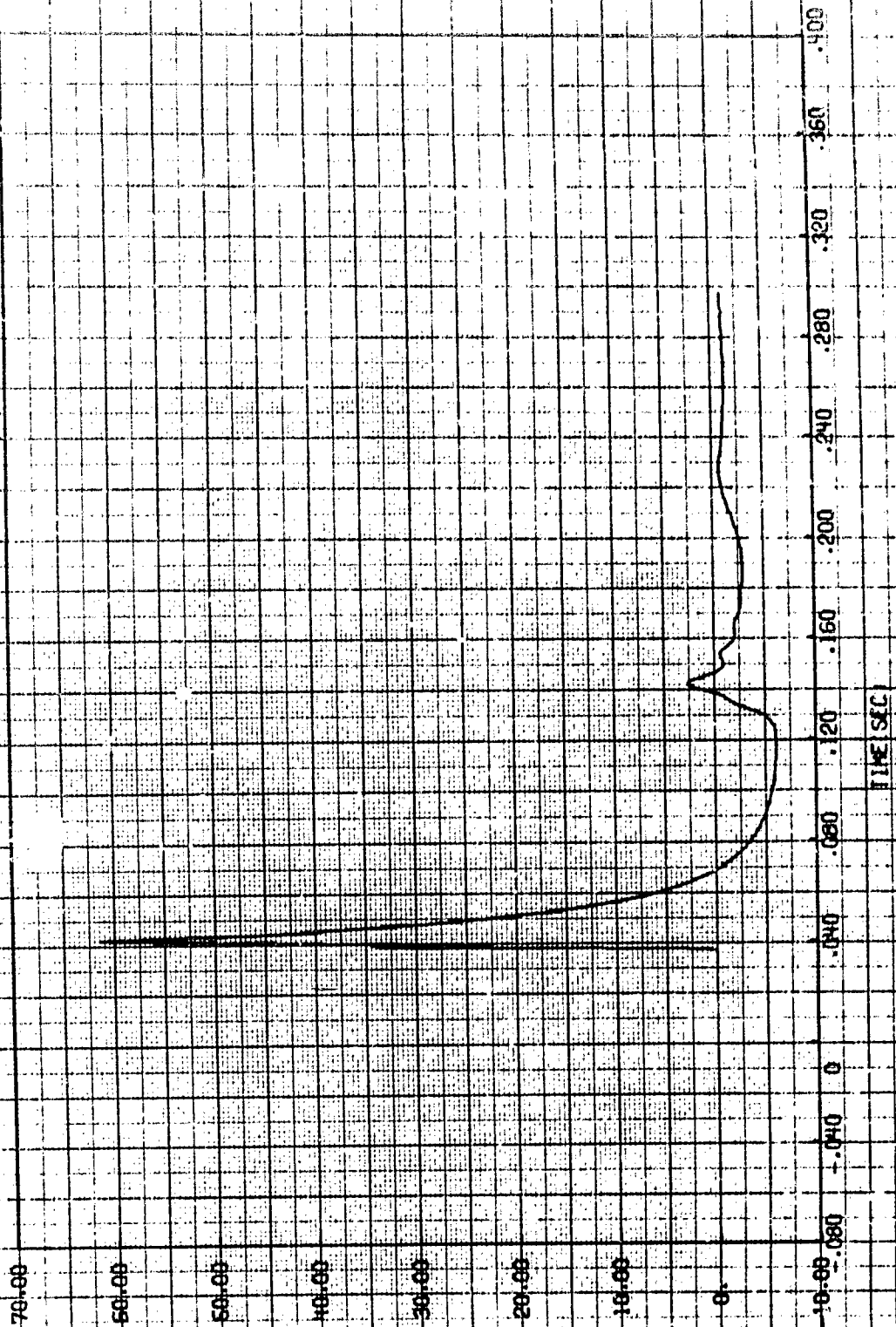
TIME (SEC)



VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 10



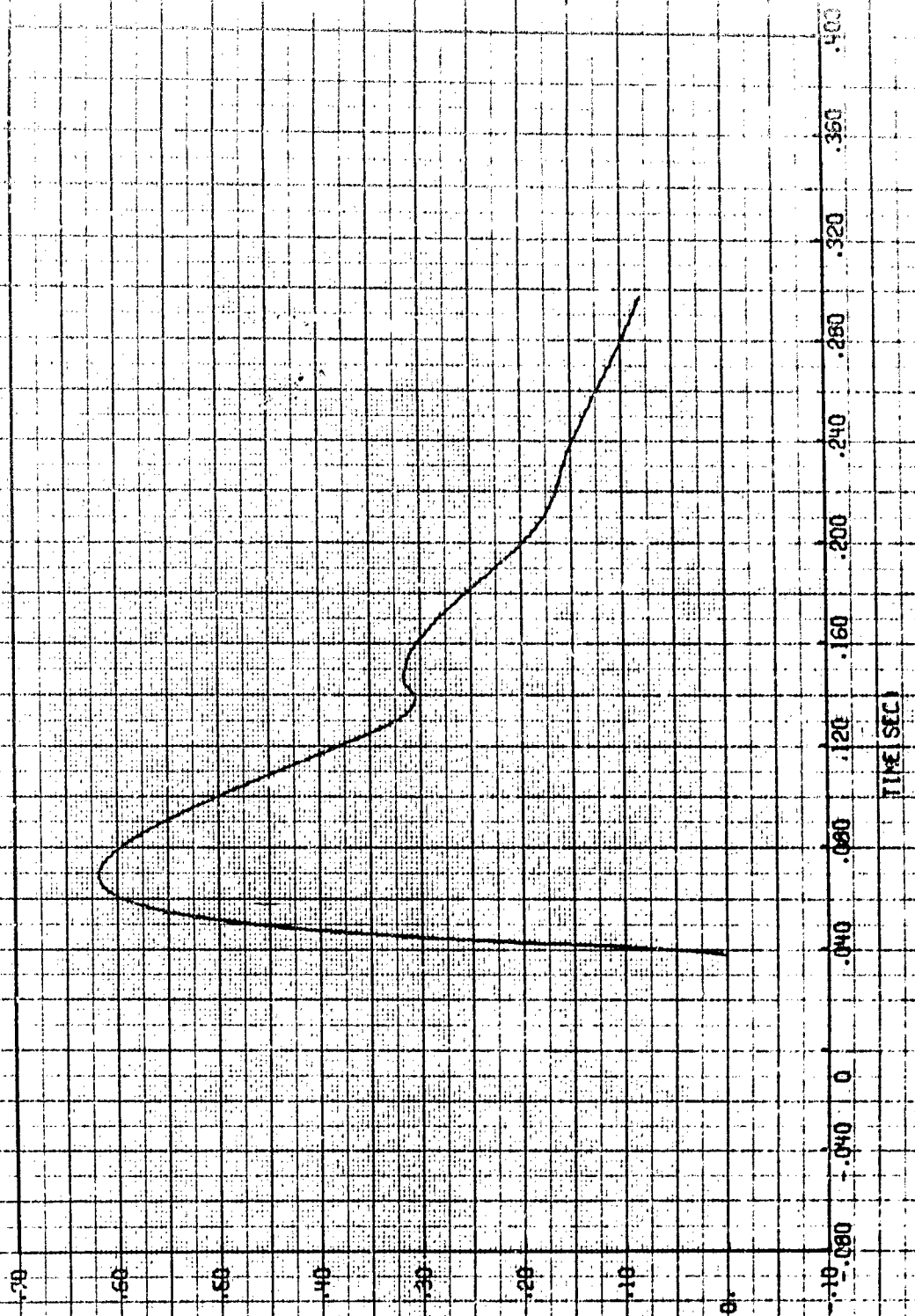
OVER PRESSURE VS TIME STATION NUMBER 11



OVER-PRESSURE (PSI)

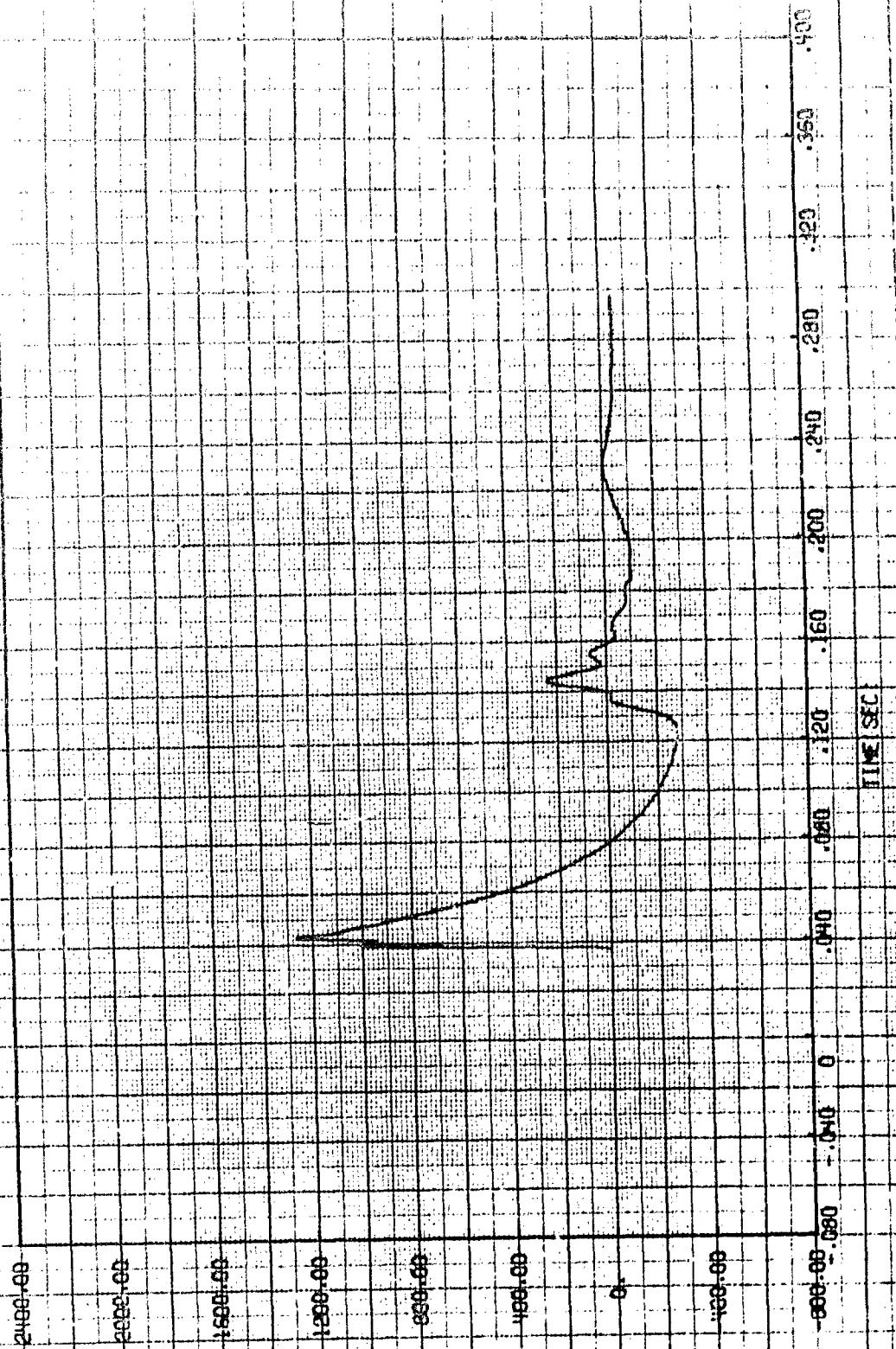
TIME (SEC)

OVER PRESSURE IMPULSE VS TIME STATION NUMBER 11



OVER PRESSURE IMPULSE (MBUS/SEC.)

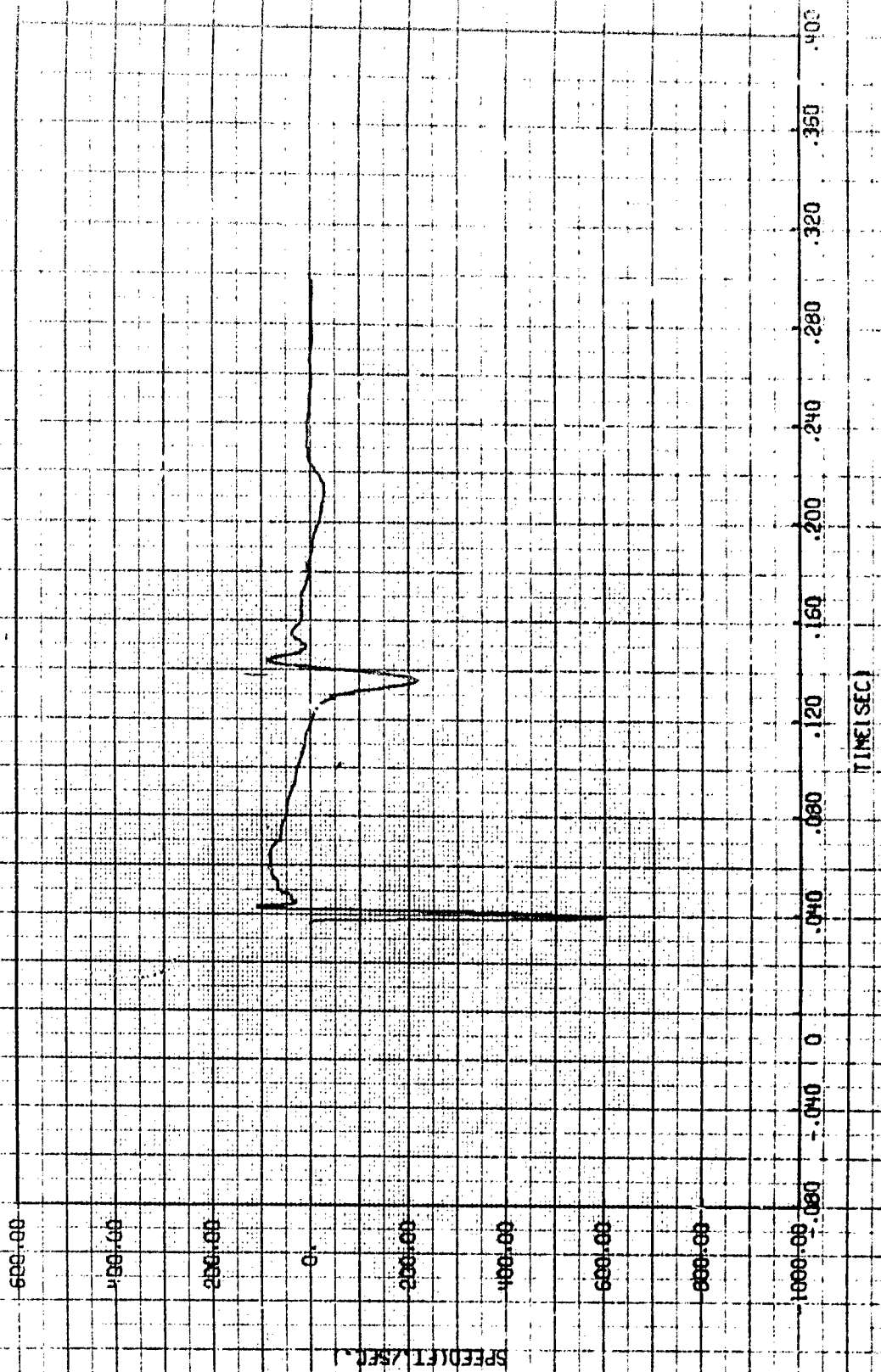
HORIZONTAL COMPONENT VELOCITY VS TIME - STATION NUMBER 11



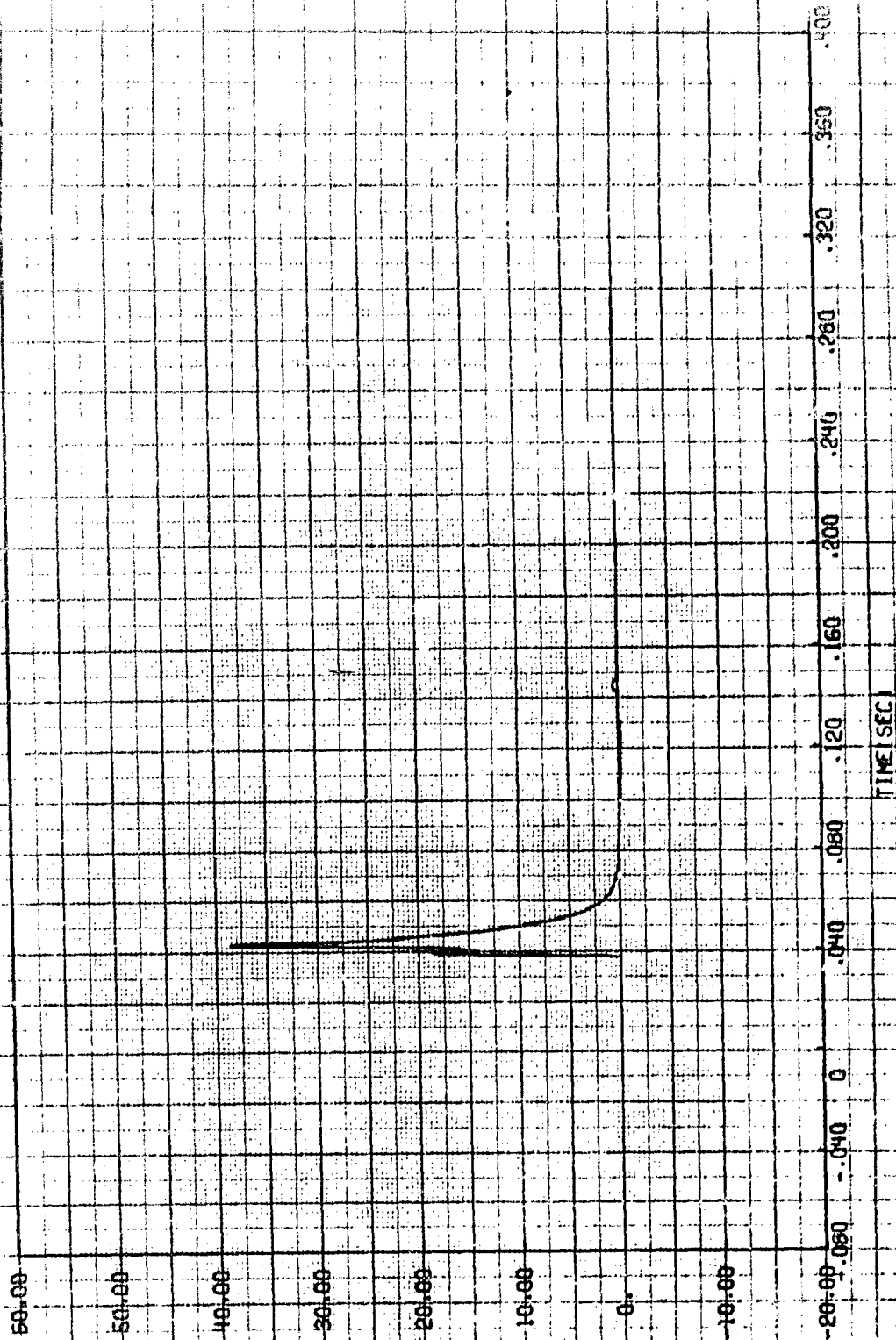
SPEED (FT./SEC.)

TIME (SEC)

VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 11

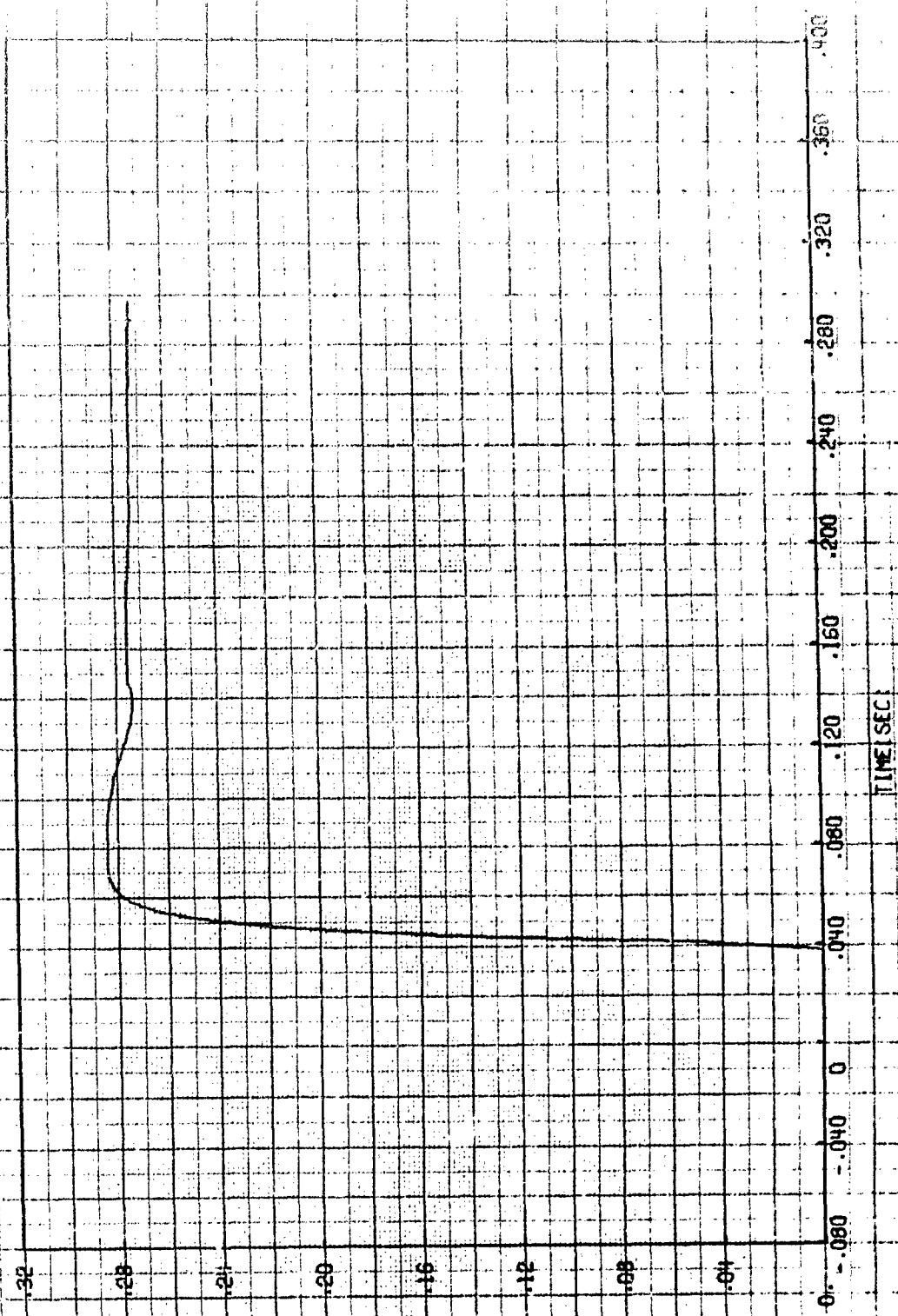


HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 11

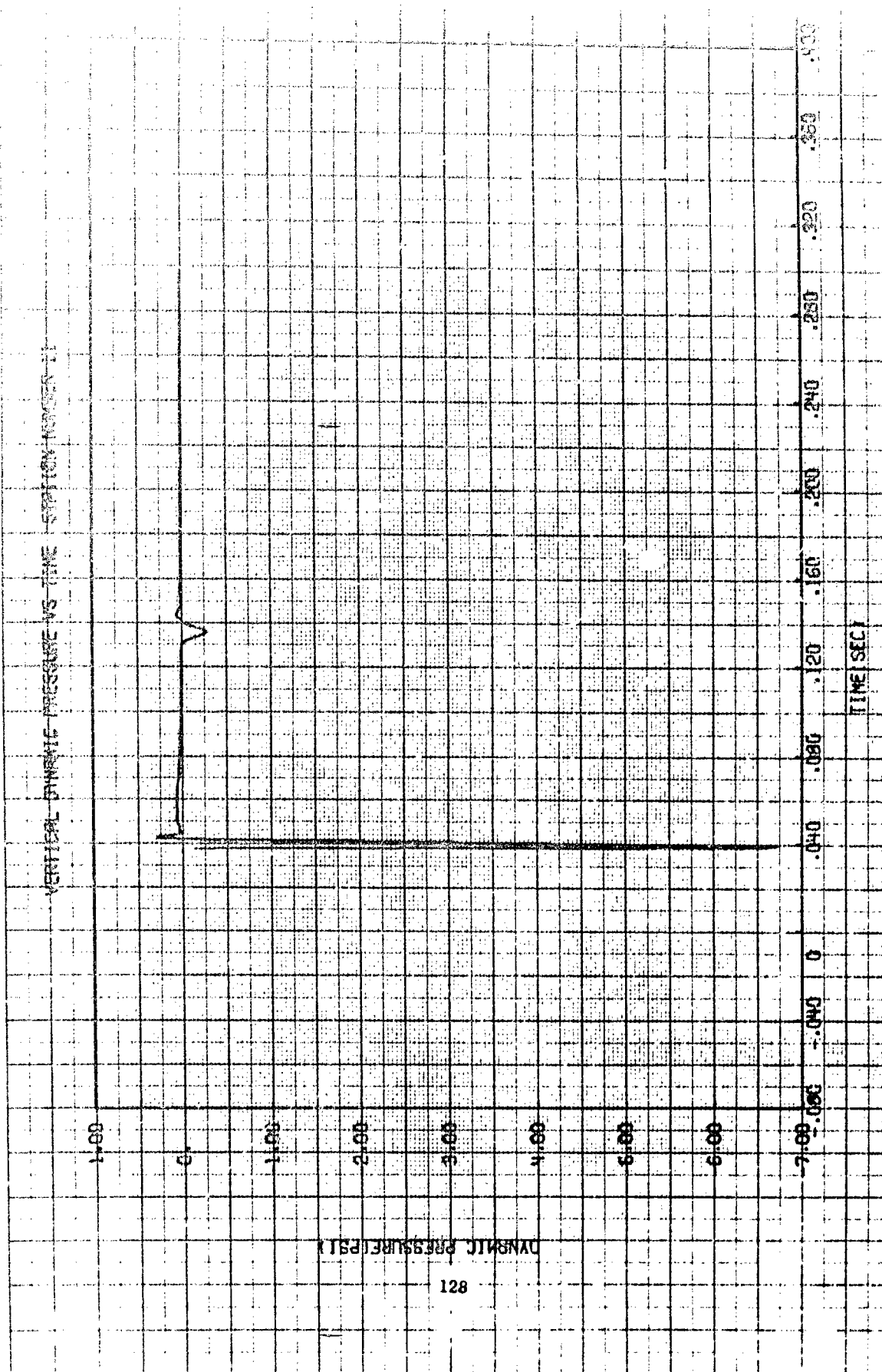


DYNAMIC PRESSURE (PSI)

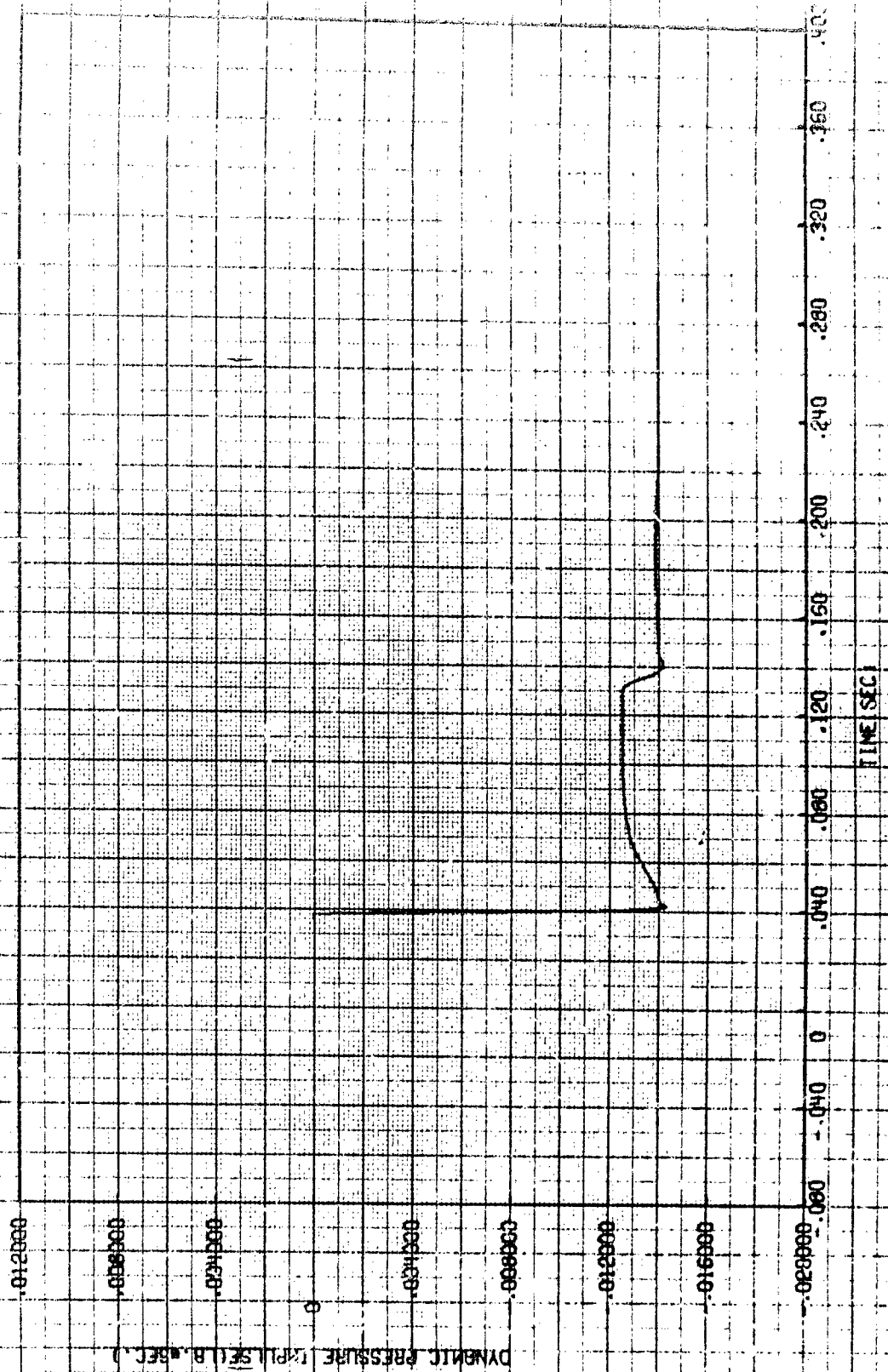
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 11

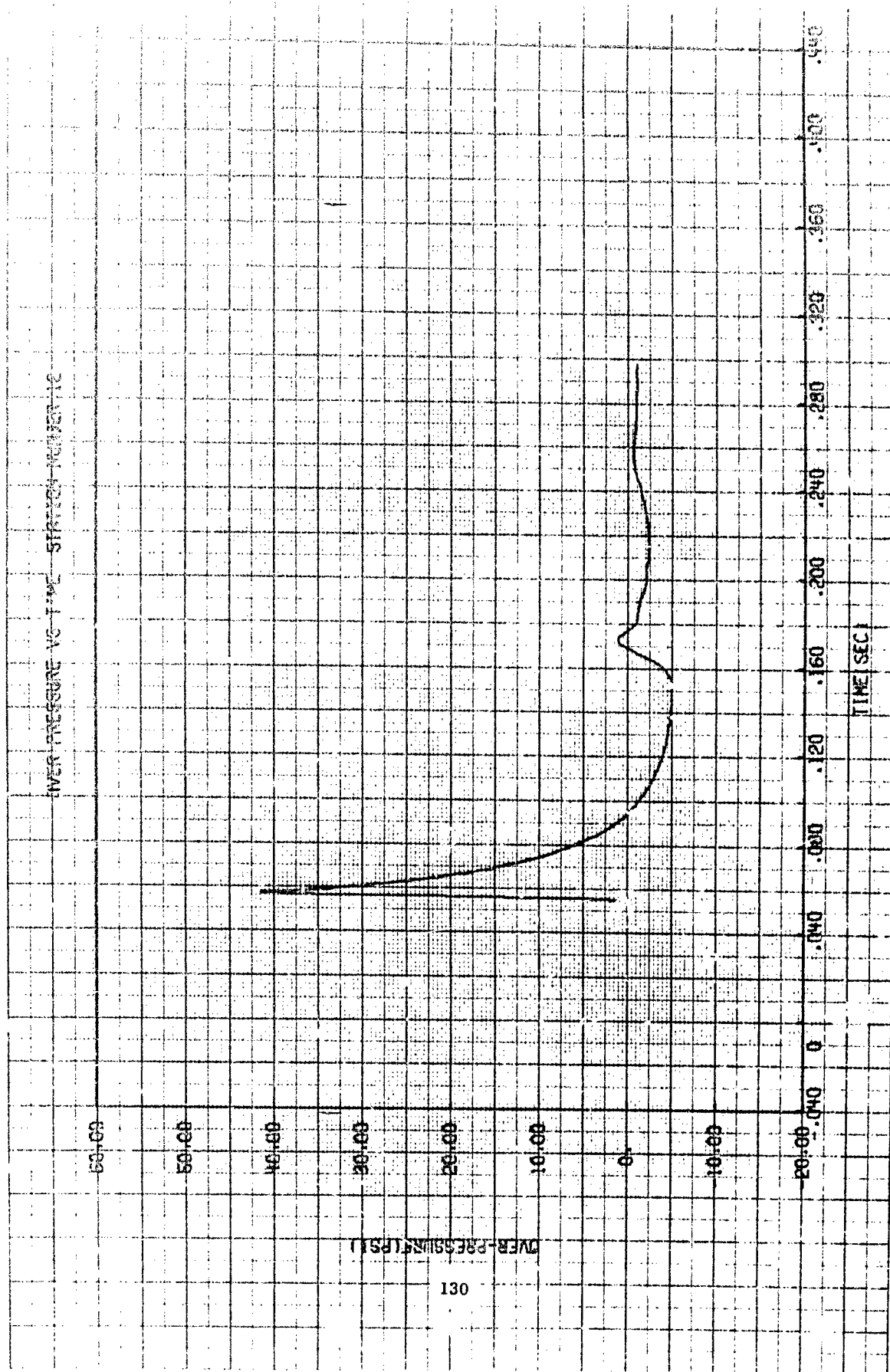


DYNAMIC PRESSURE IMPULSE (LBS/SEC. IN)

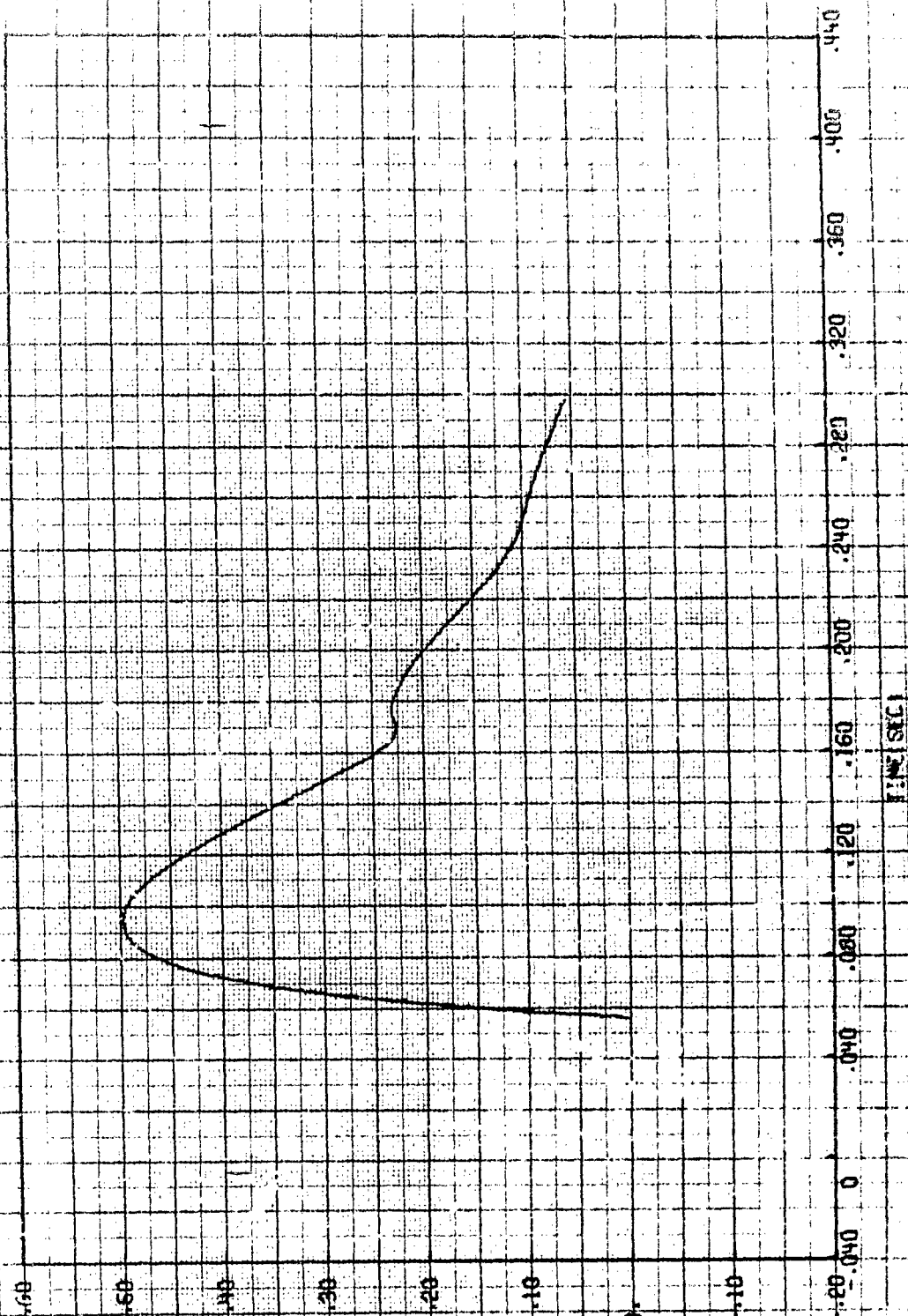


VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 11



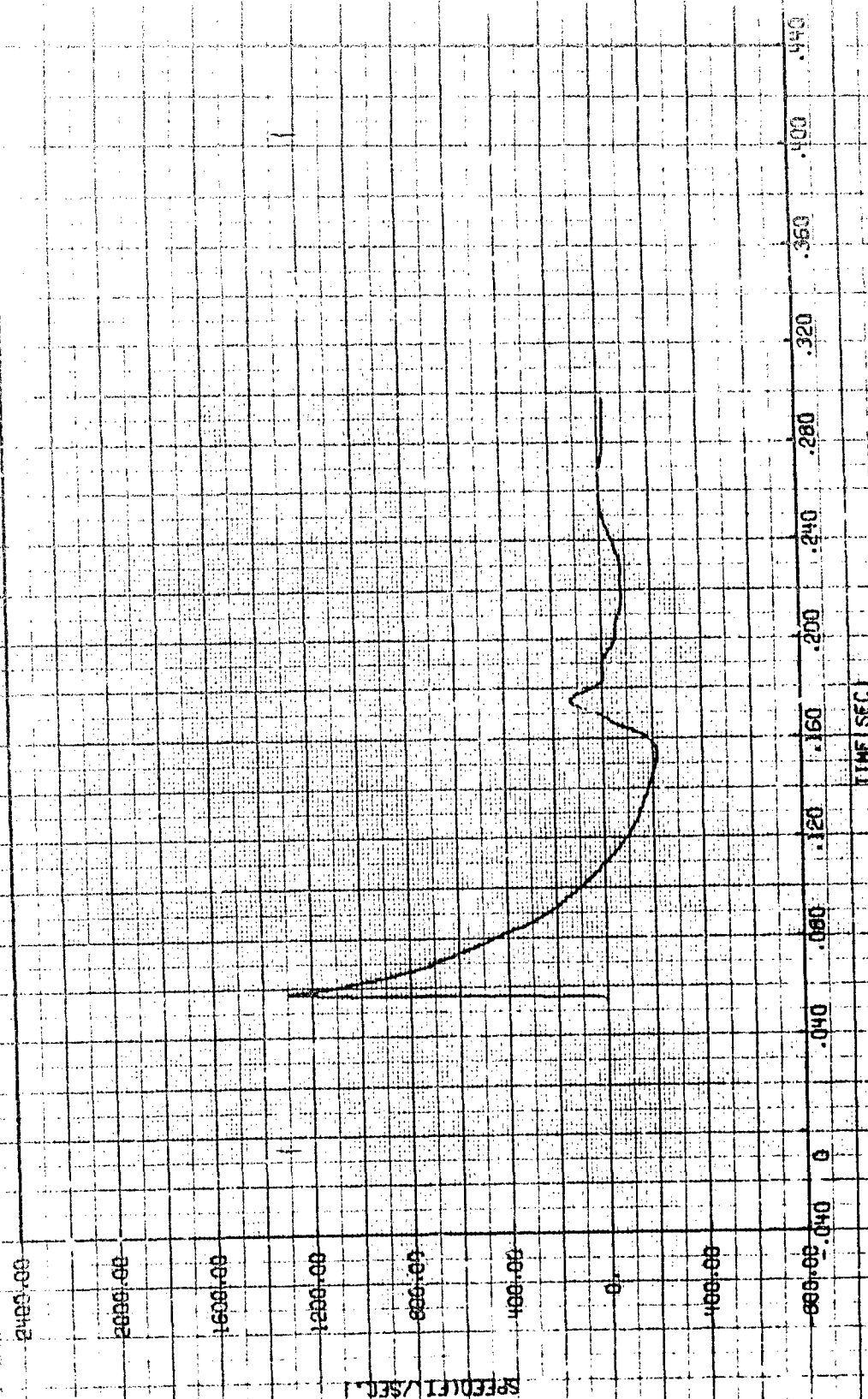


OVER PRESSURE IMPULSE VS TIME STATION NUMBER 12

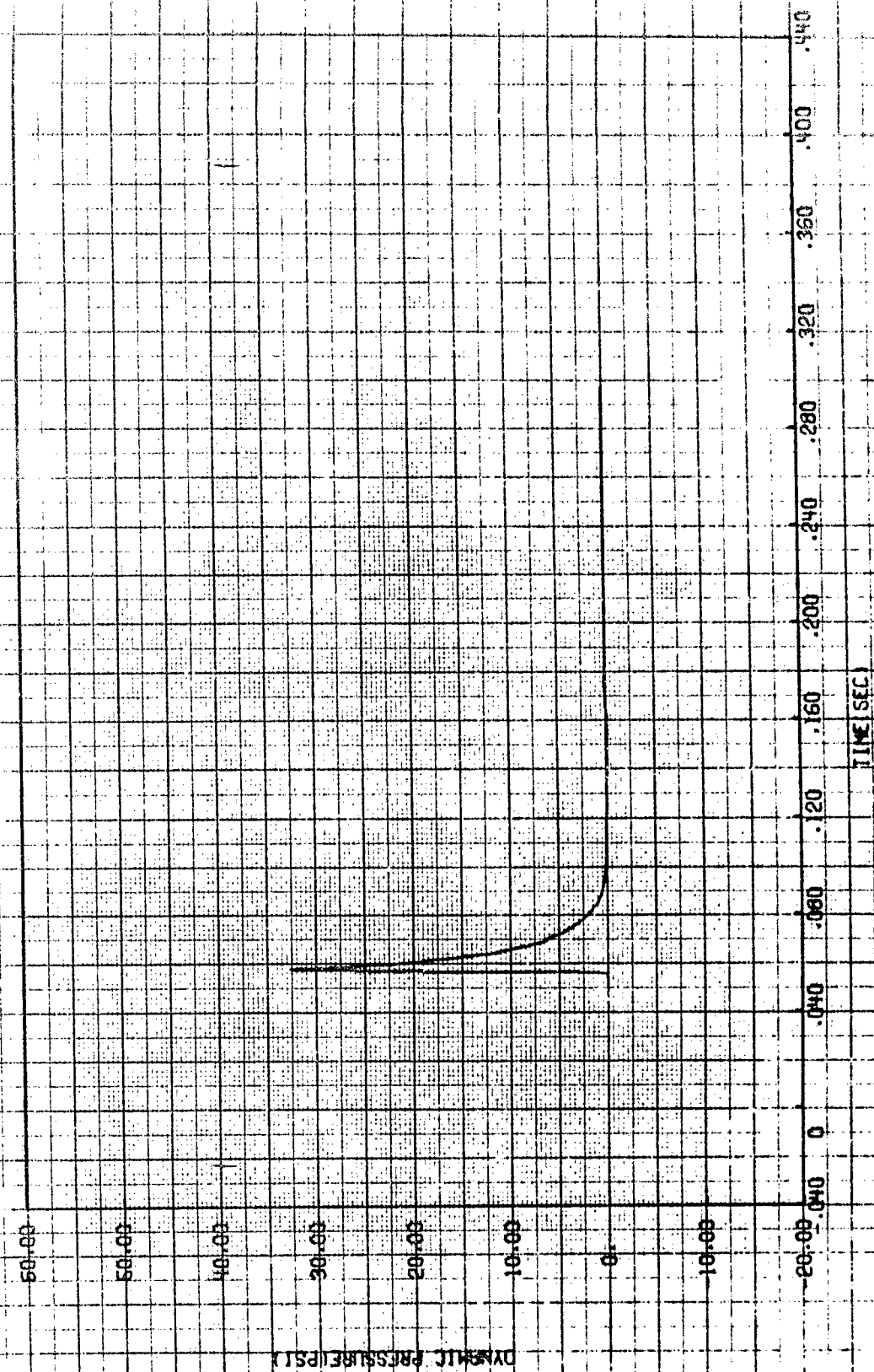


OVER PRESSURE IMPULSE (MBAR SEC)

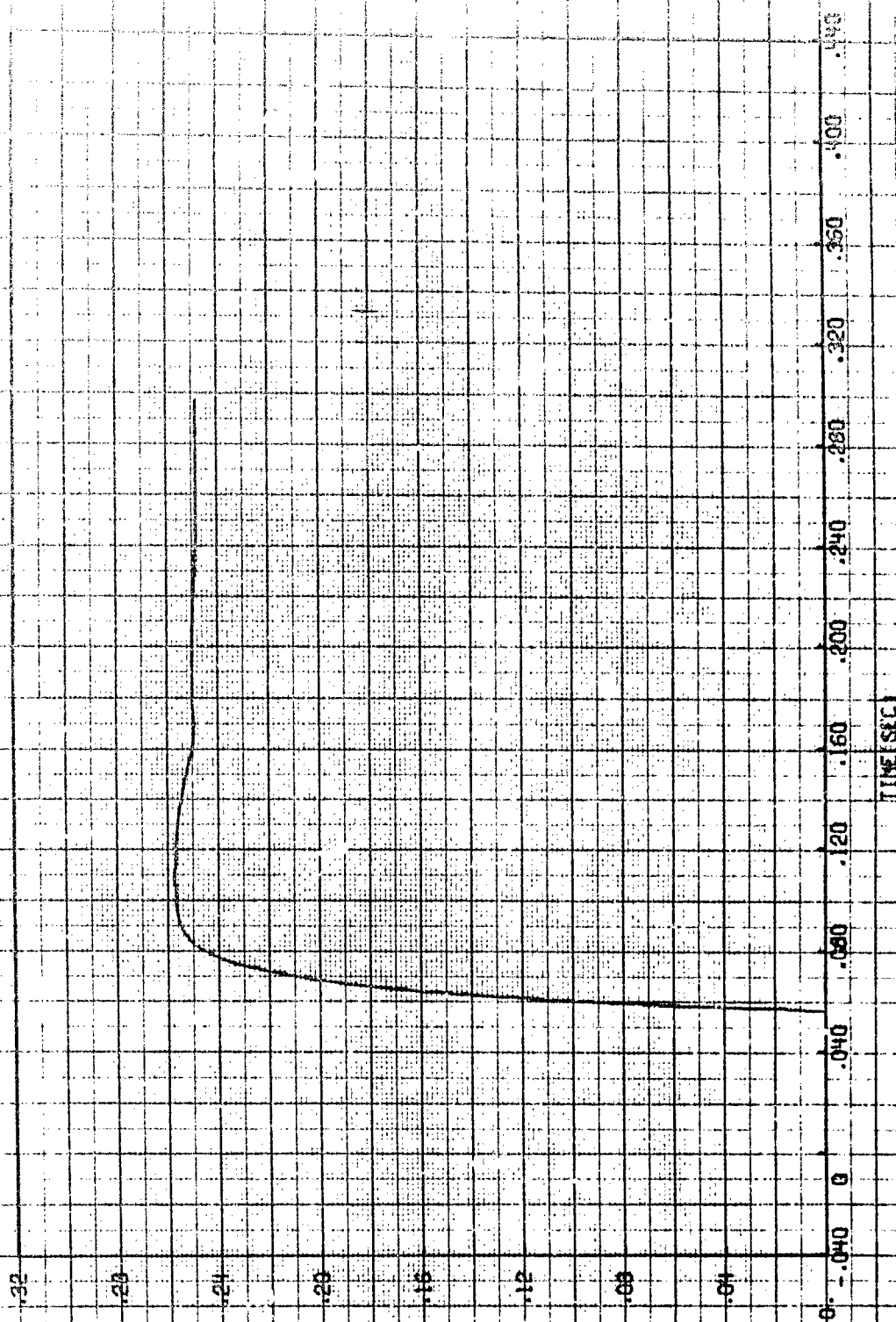
HORIZONTAL COMPONENT VELOCITY VS TIME - STATION NUMBER 12



HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 12

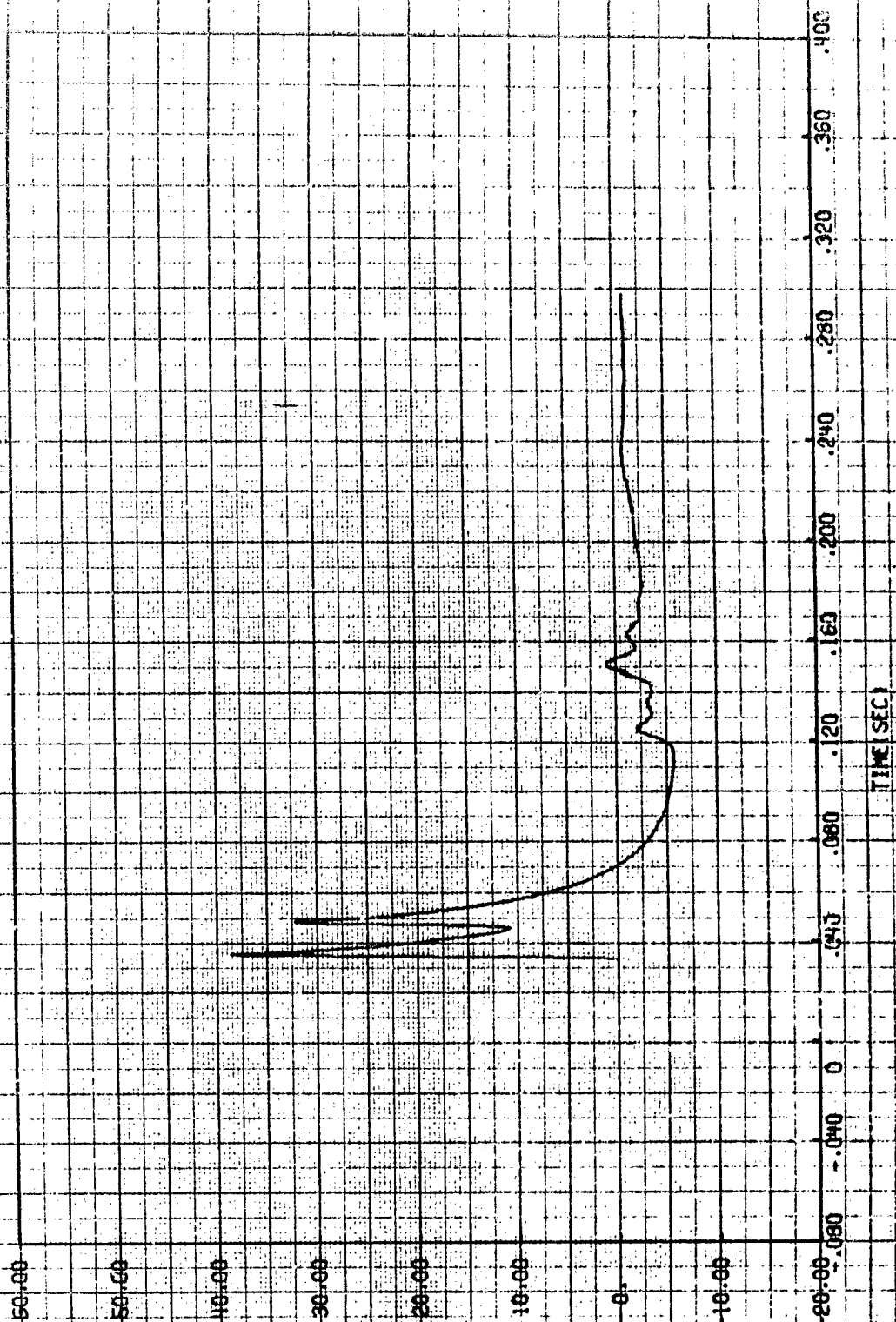


HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME - CONTINUOUS TEST



DYNAMIC PRESSURE IMPULSE (LB. SEC.)

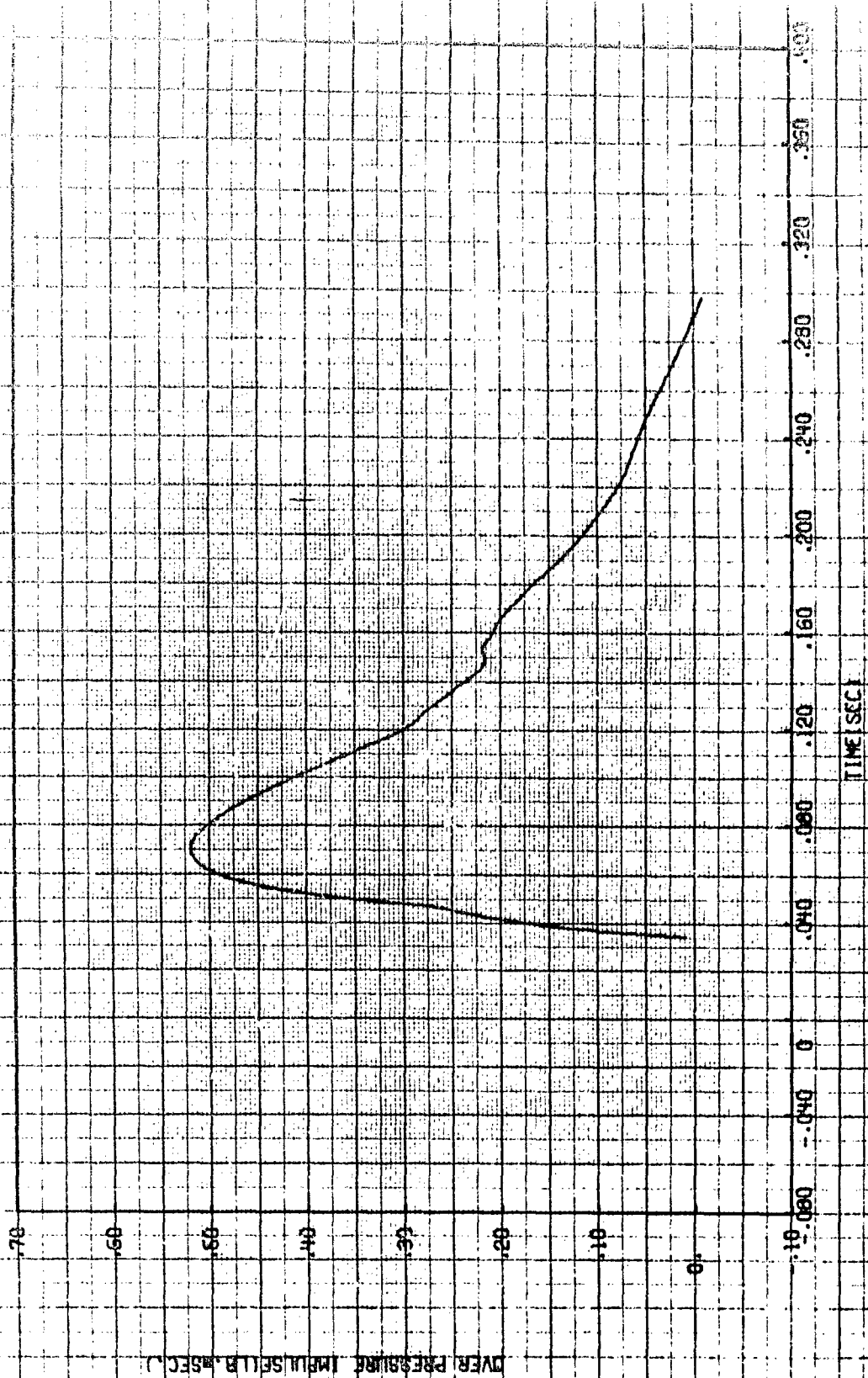
OVER PRESSURE VS TIME STATION NUMBER 13



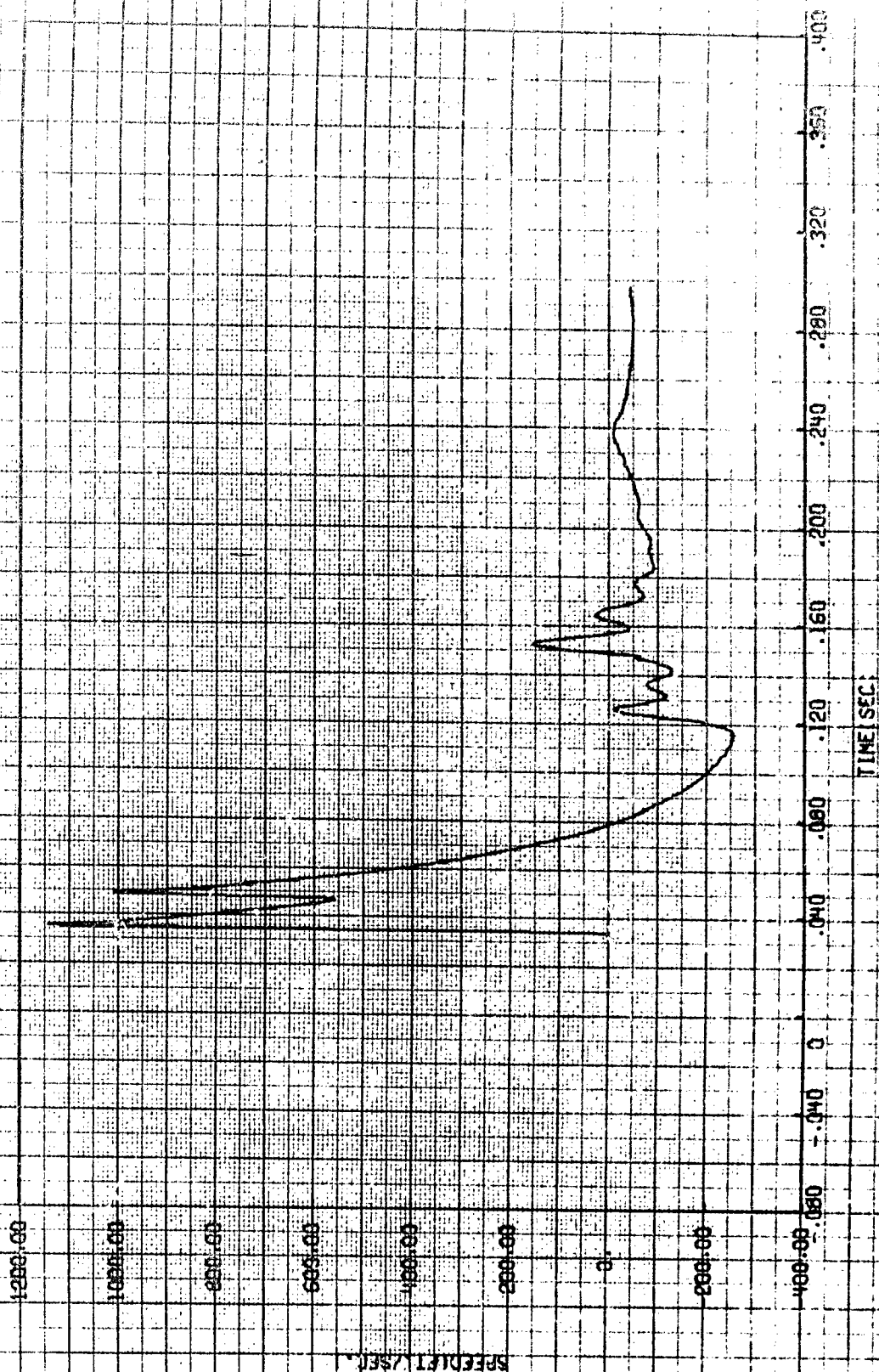
OVER PRESSURE (PSI)

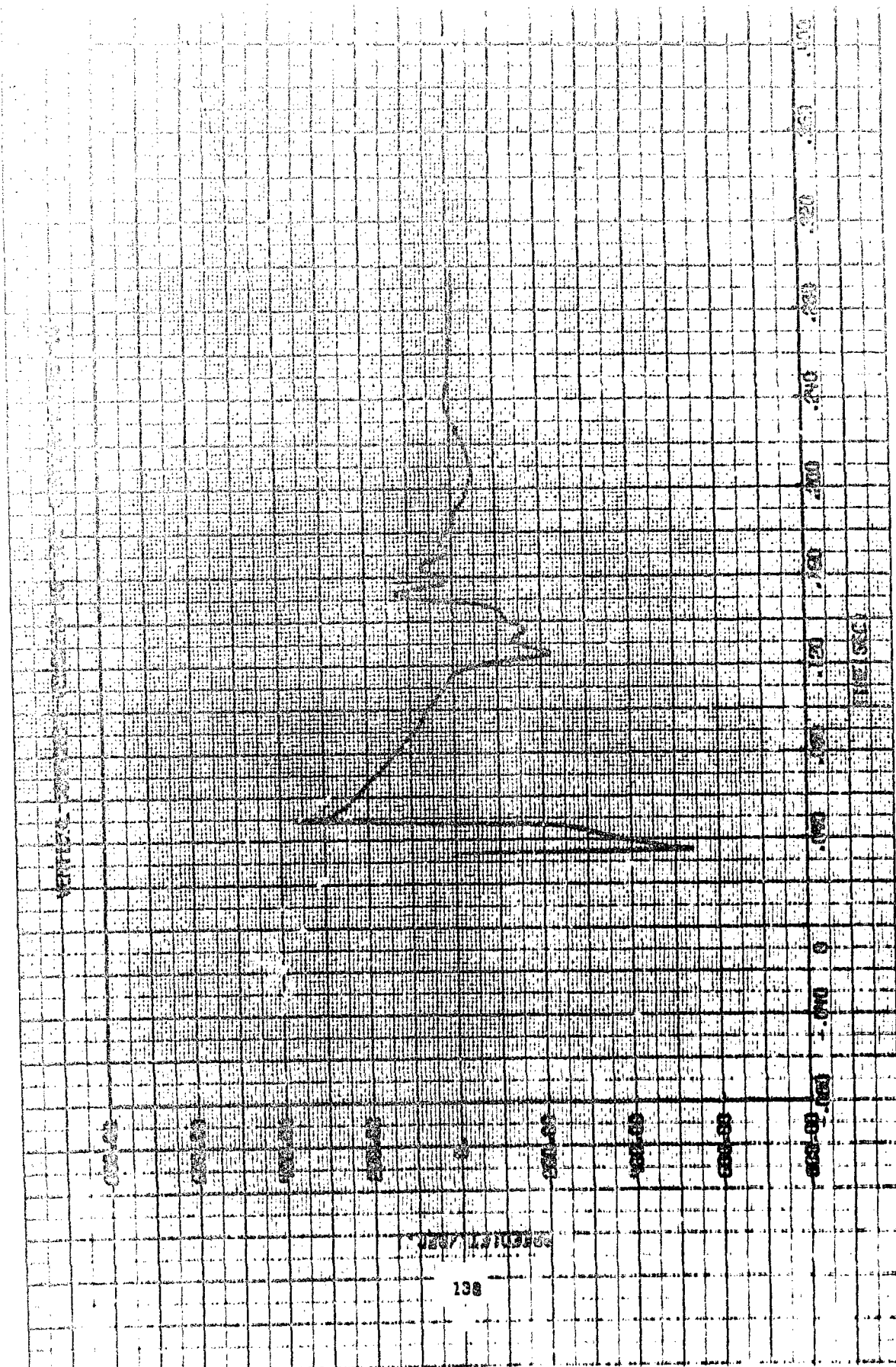
TIME (SEC)

OVER PRESSURE IMPULSE VS TIME (STATION NUMBER 10)

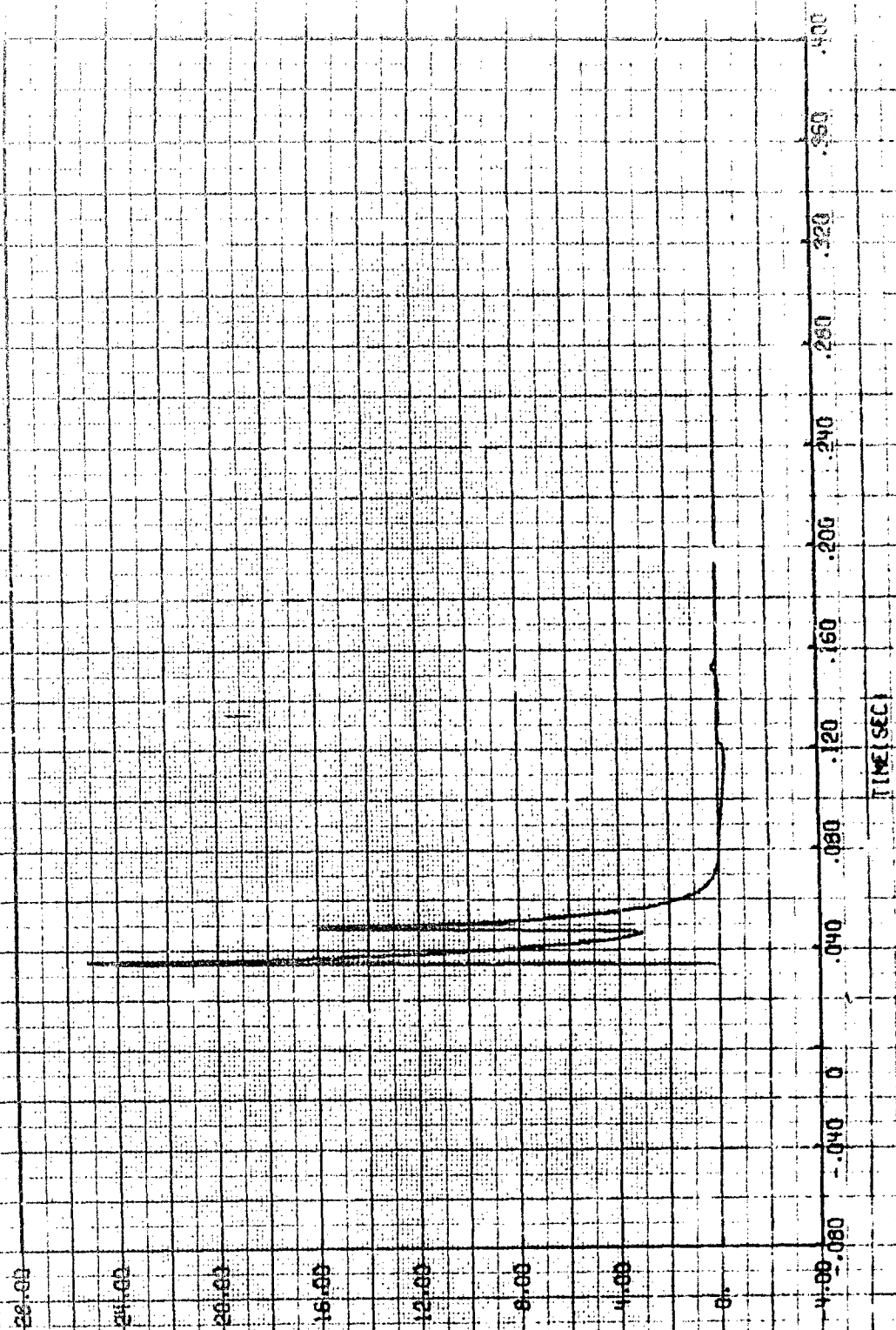


HORIZONTAL COMPONENT VELOCITY VS TIME SECTION NUMBER 13



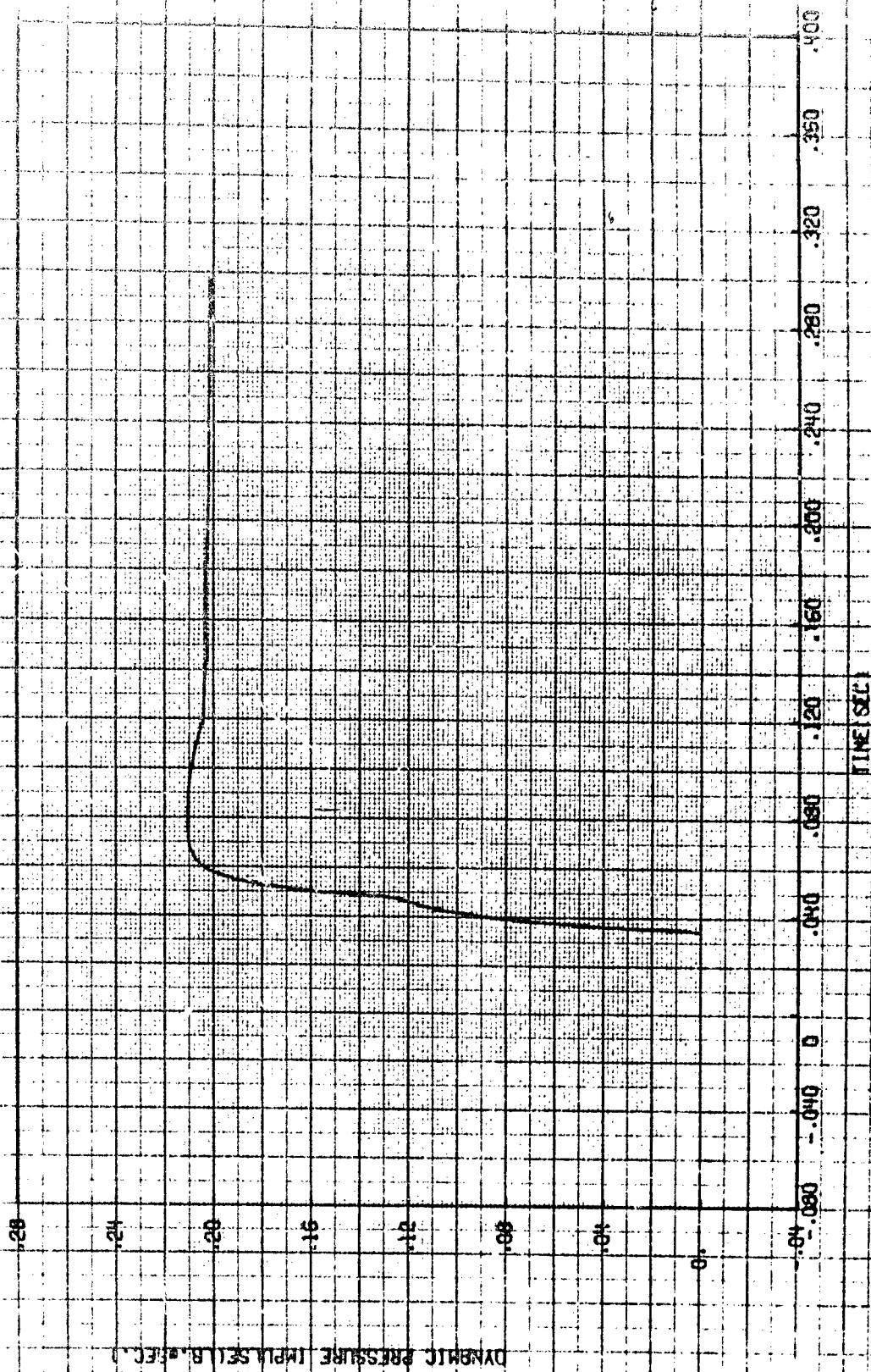


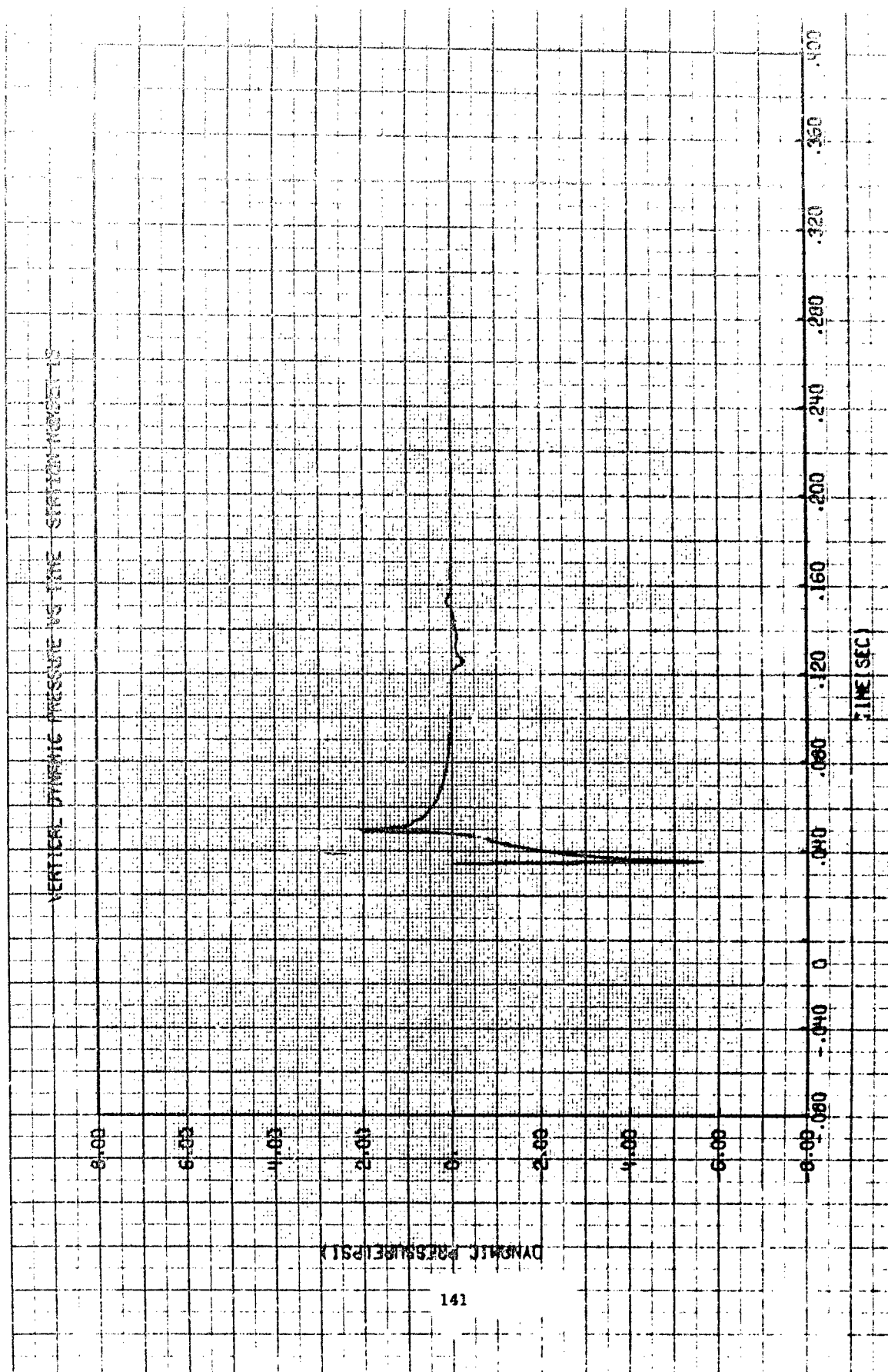
HORIZONTAL DYNAMIC PRESSURE VS TIME - STATION NUMBER 12



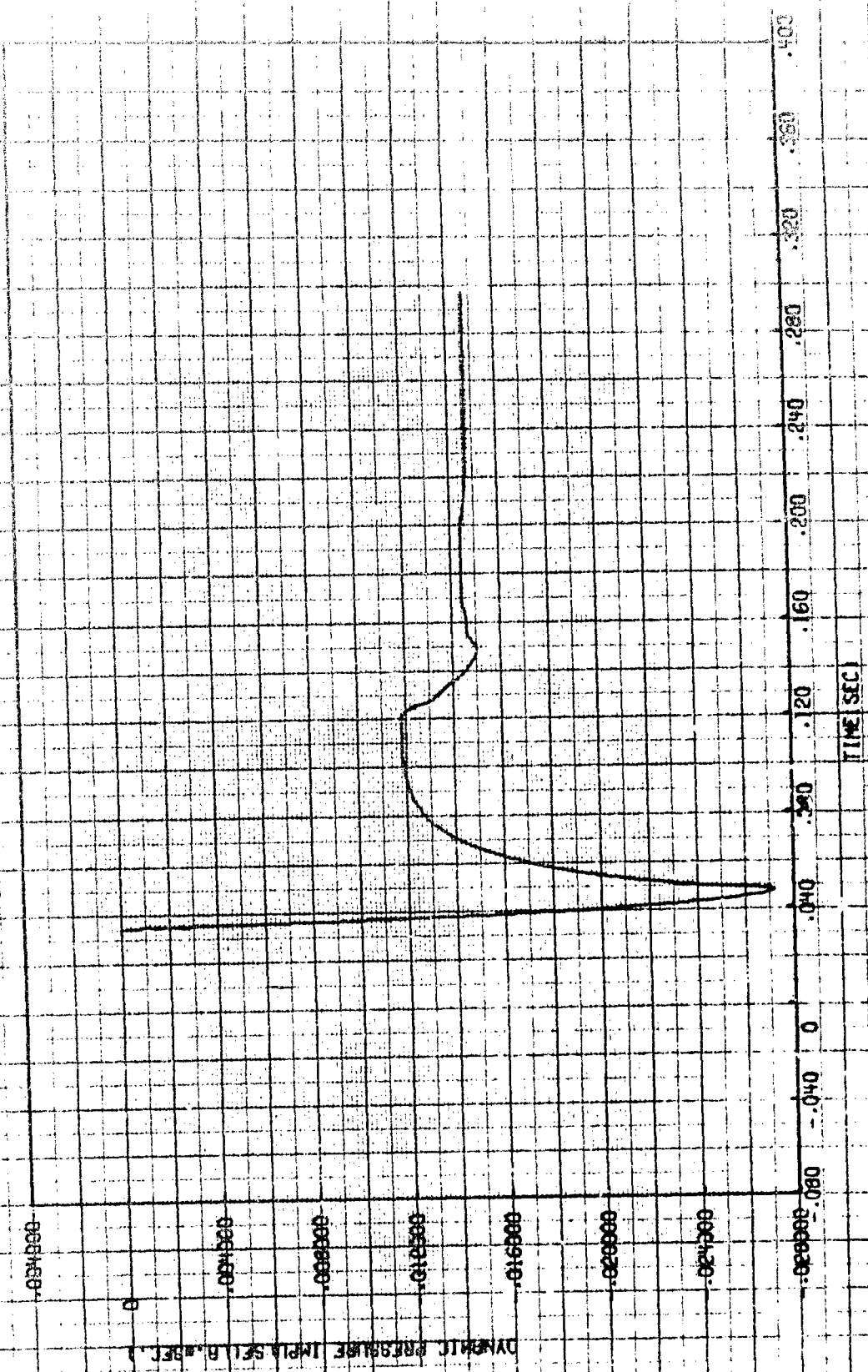
DYNAMIC PRESSURE (PSI)

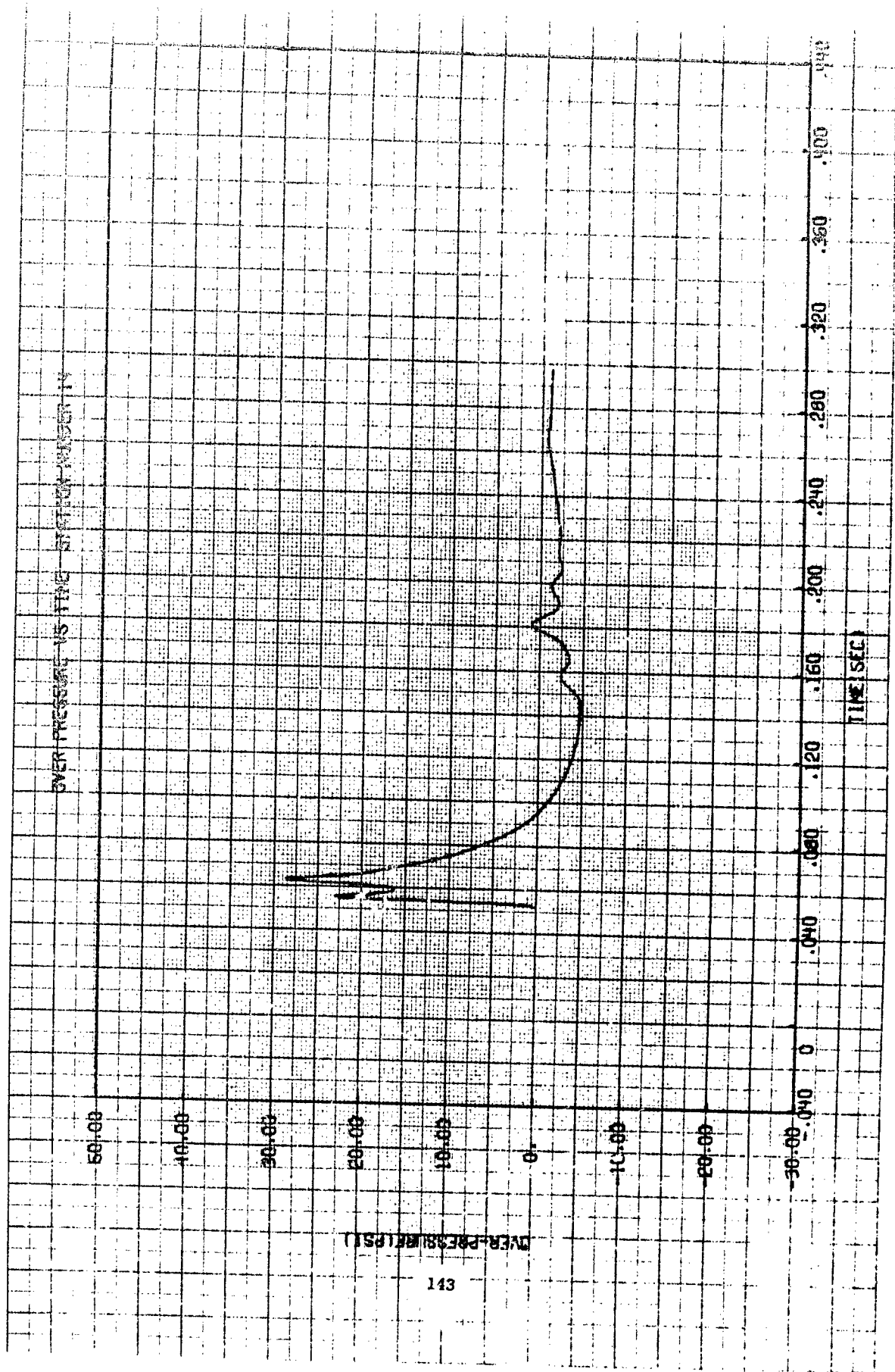
HORIZONTAL DYNAMIC PRESSURE IMPULSE NO. 1115 STATION NUMBER 15



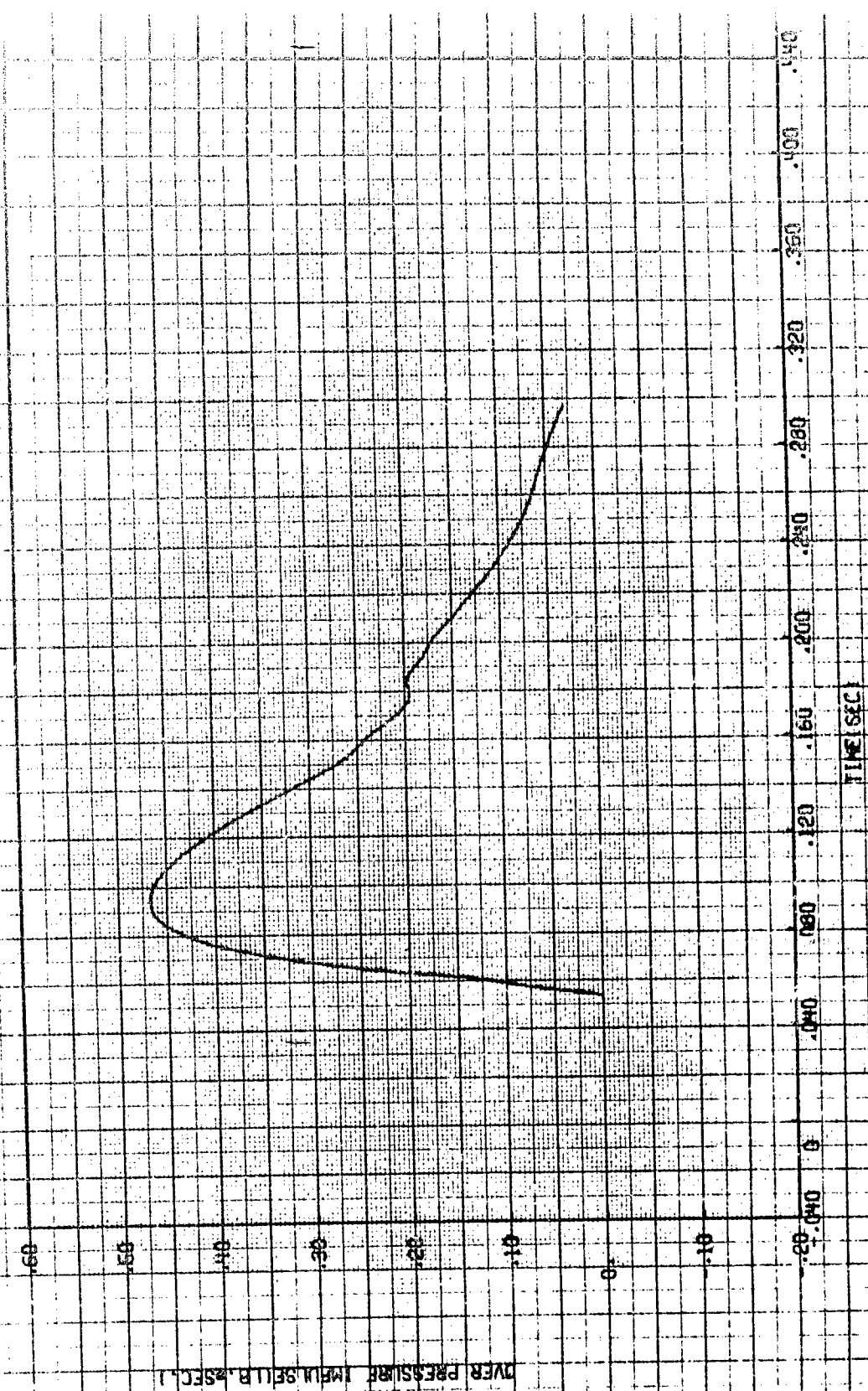


VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 19

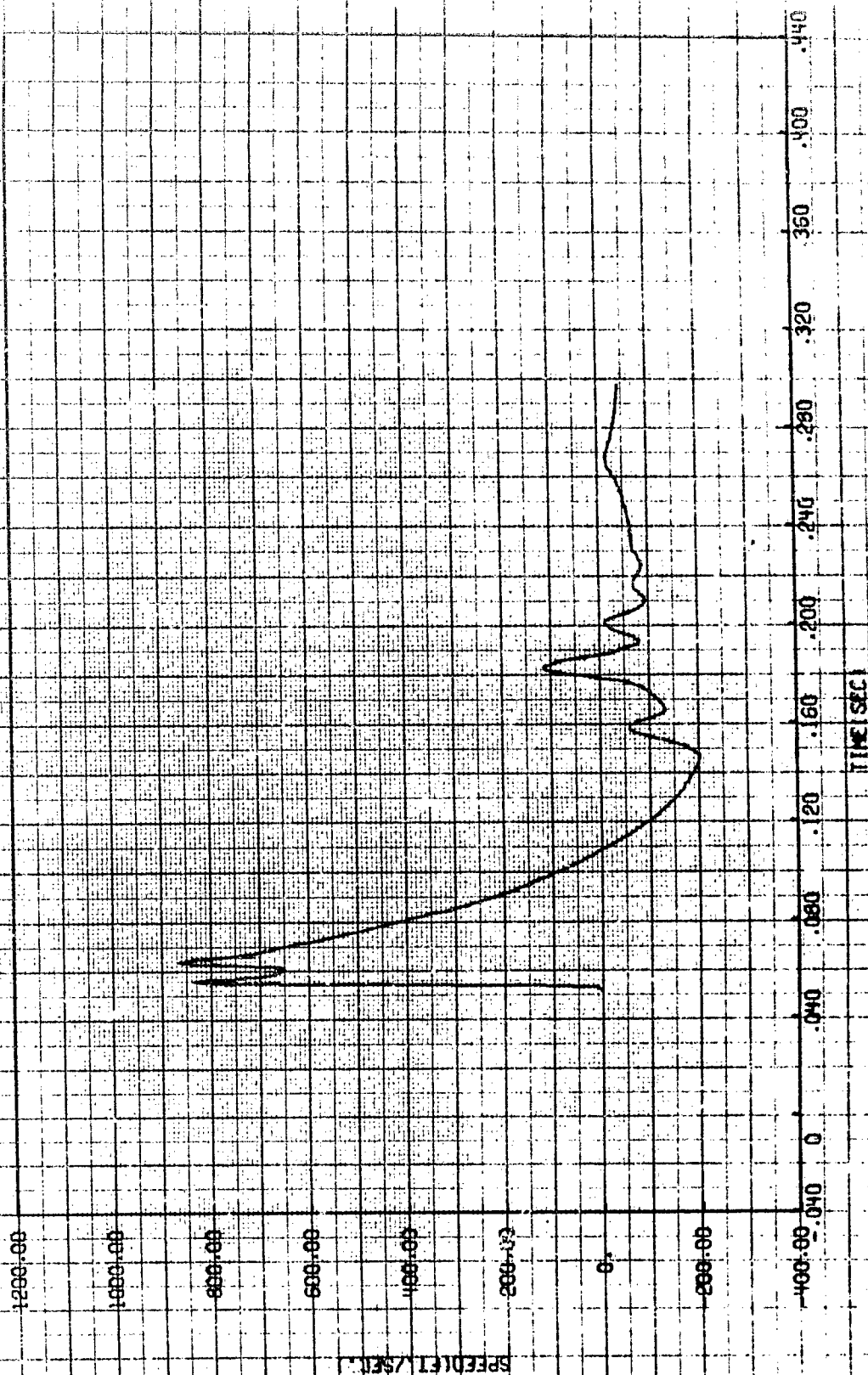




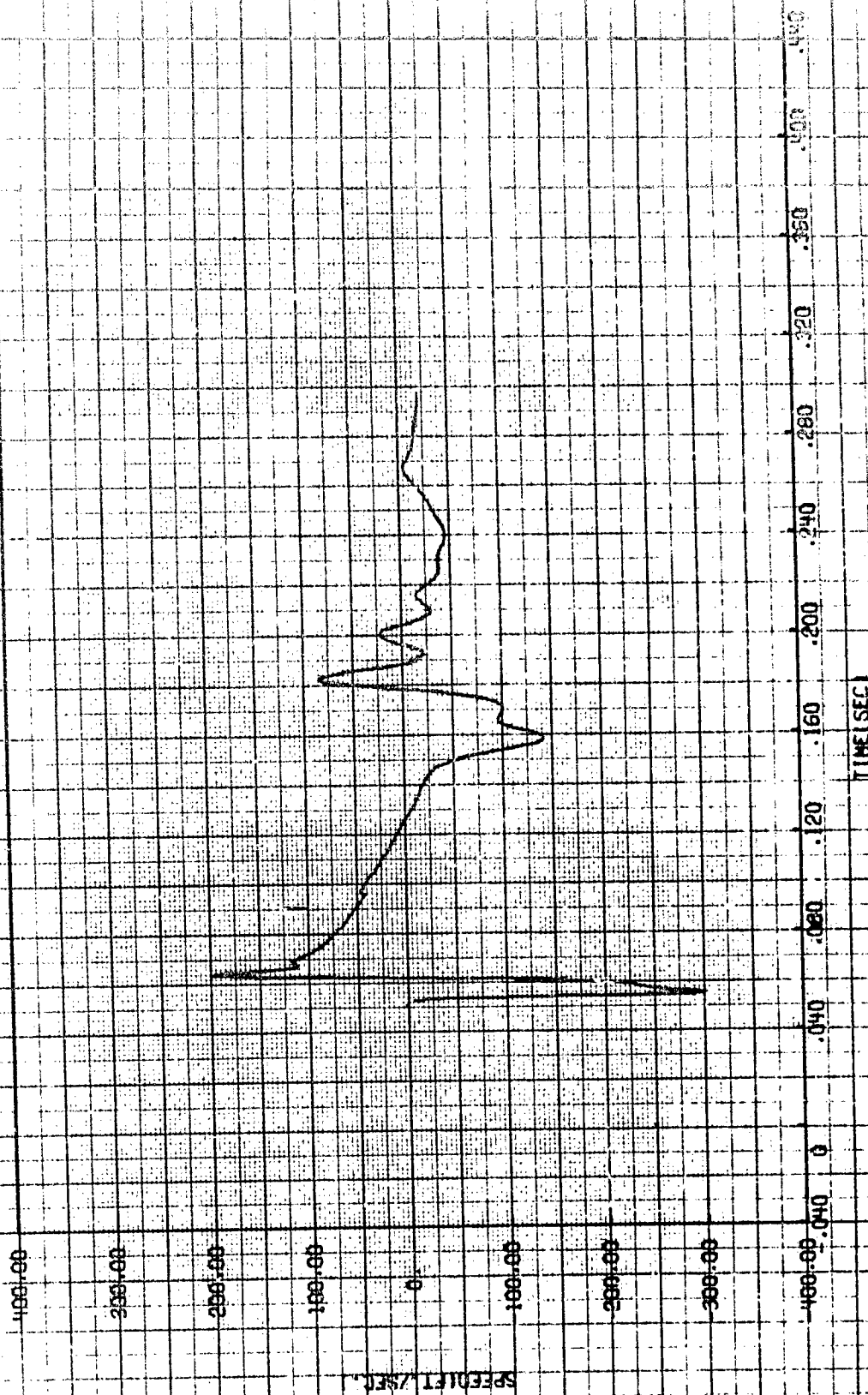
OVER PRESSURE IMPULSE VS TIME - JANISCH 4000-14



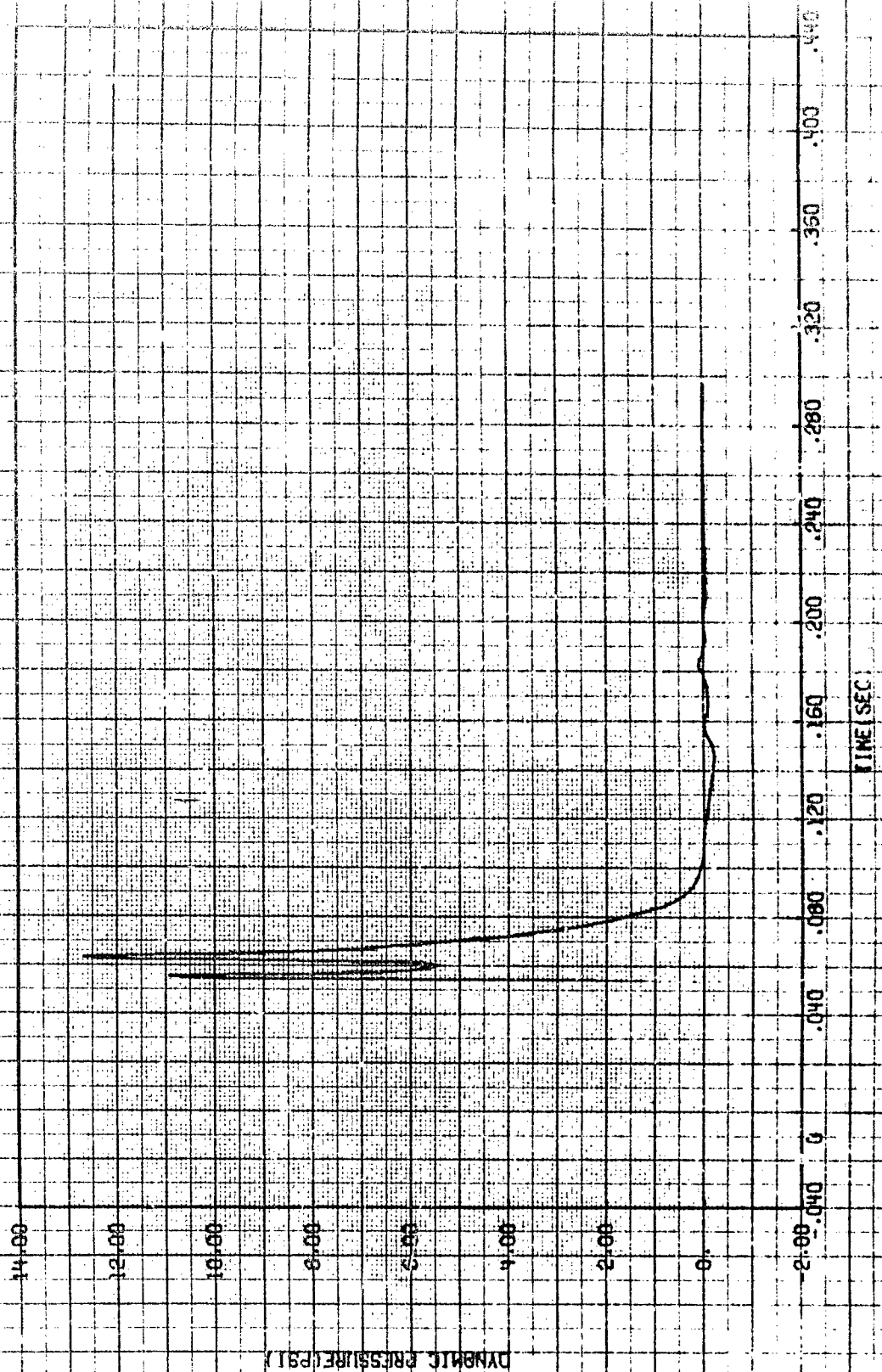
HORIZONTAL COMPONENT VELOCITY VS TIME - STATION NUMBER 14



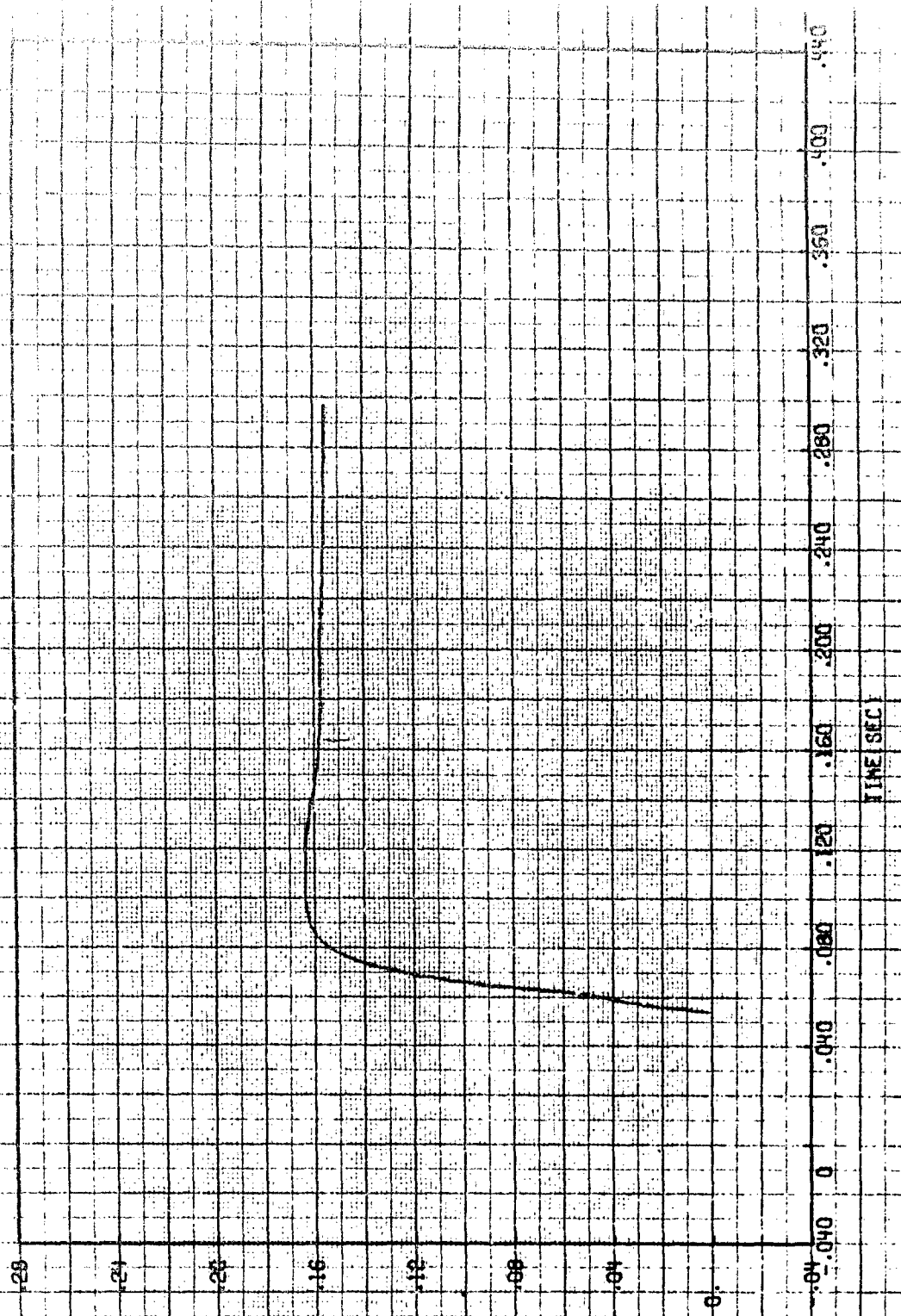
VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 19



HORIZONTAL ENGINE PRESSURE VS TIME - STATION NUMBER 11



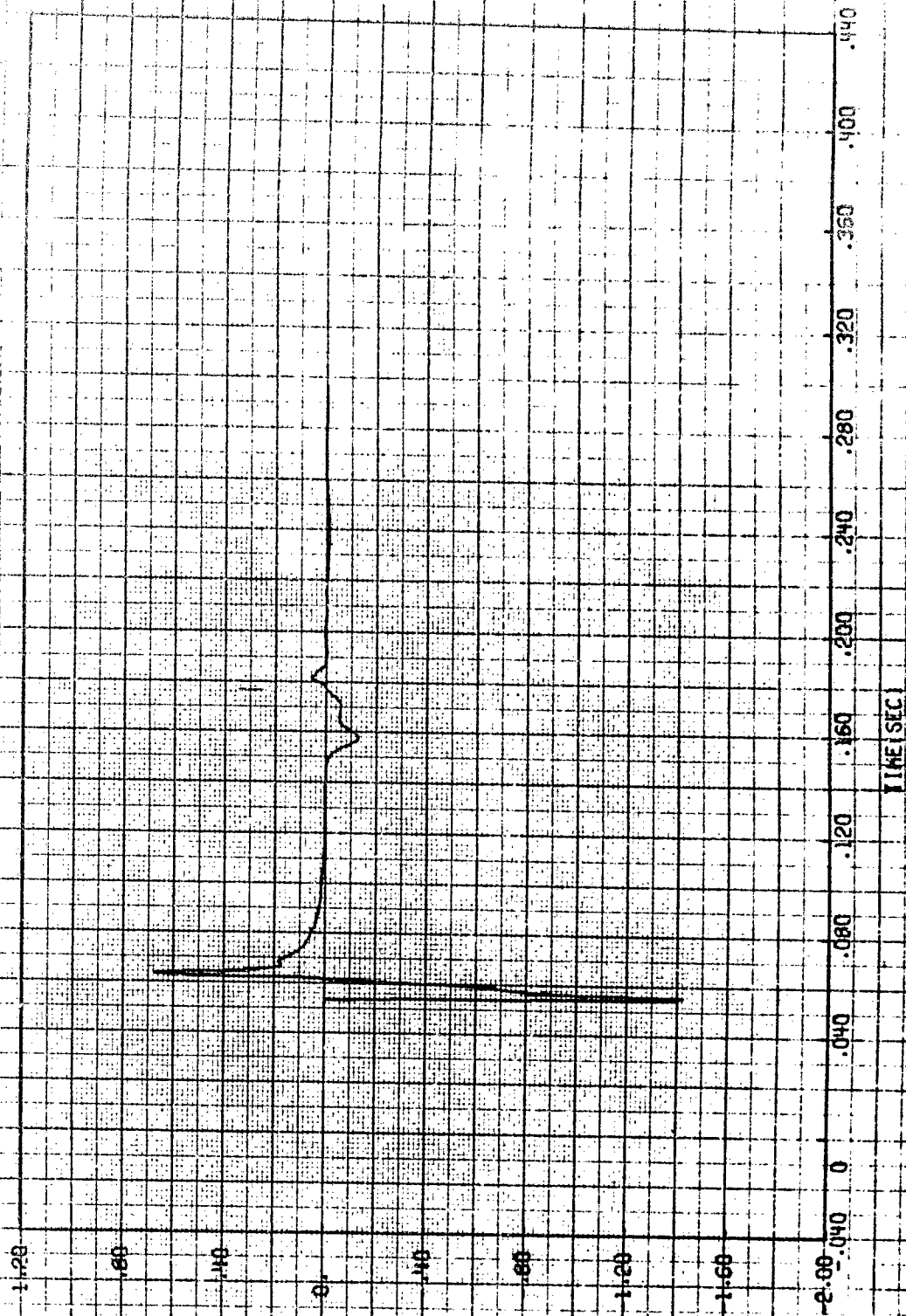
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME - STATION NUMBER 1



DYNAMIC PRESSURE (LBS./SQ. IN.)

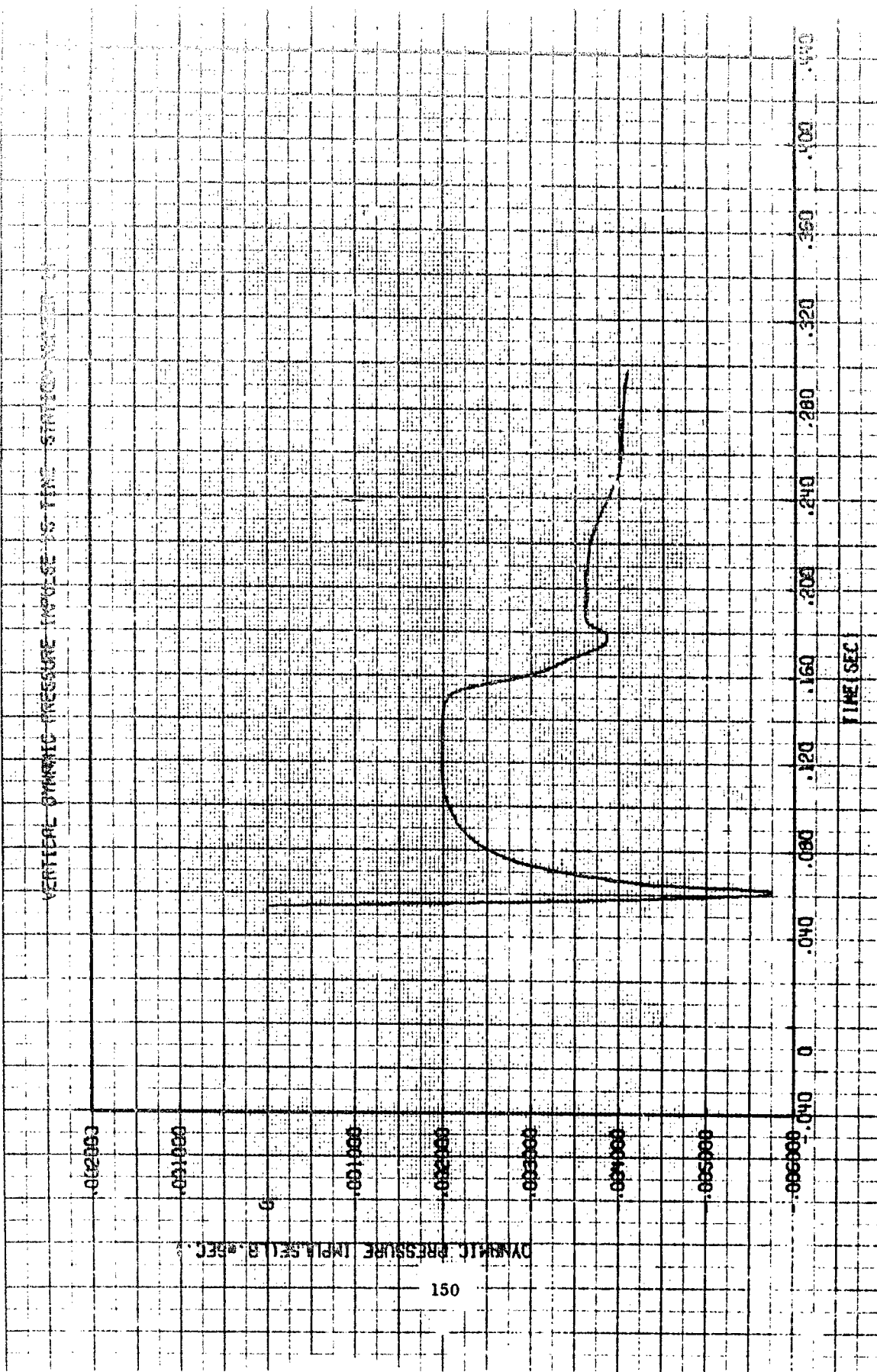
TIME (SEC)

VERTICAL DYNAMIC PRESSURE VS TIME STATION NUMBER 14

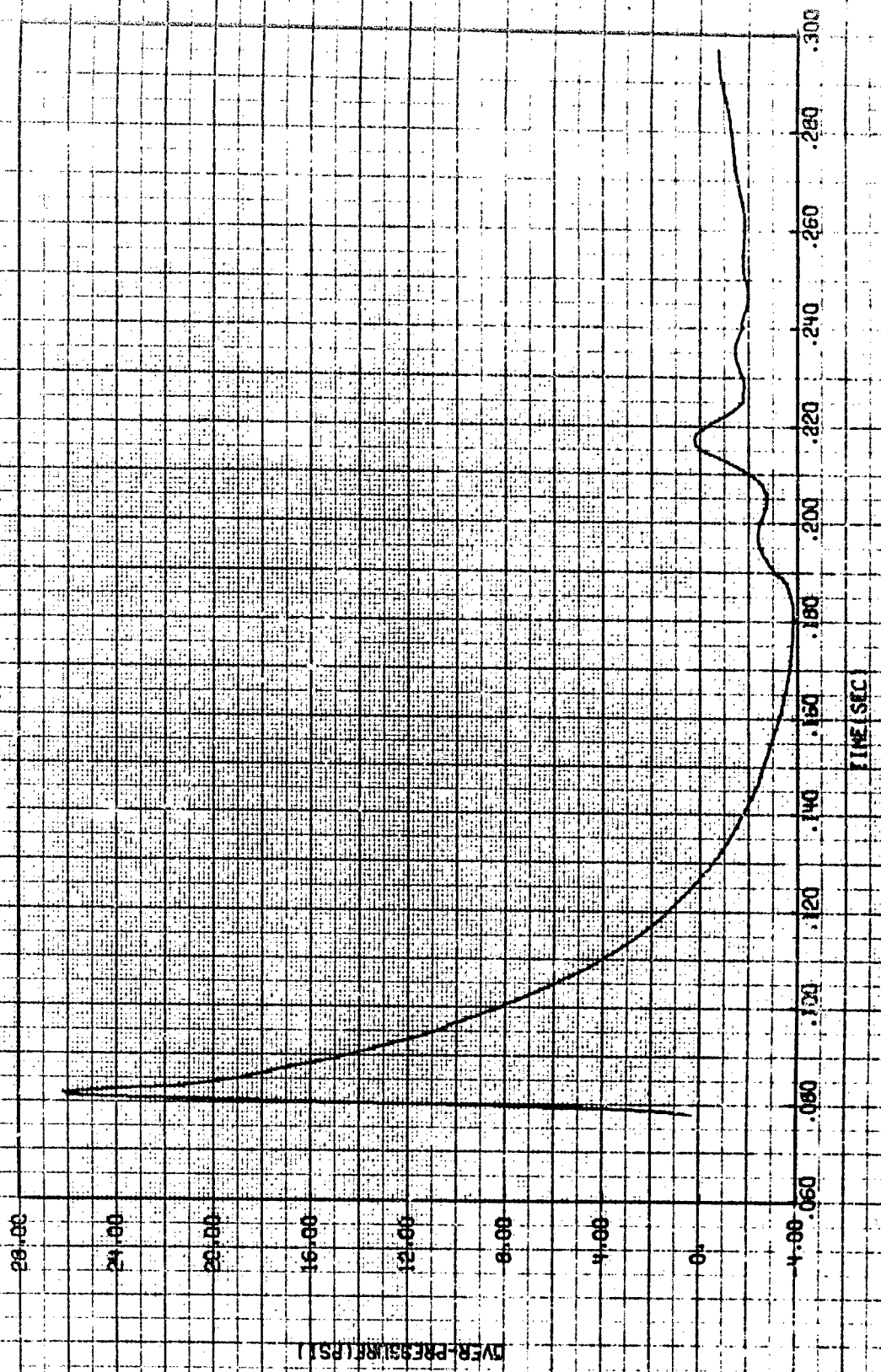


DYNAMIC PRESSURE (PSI)

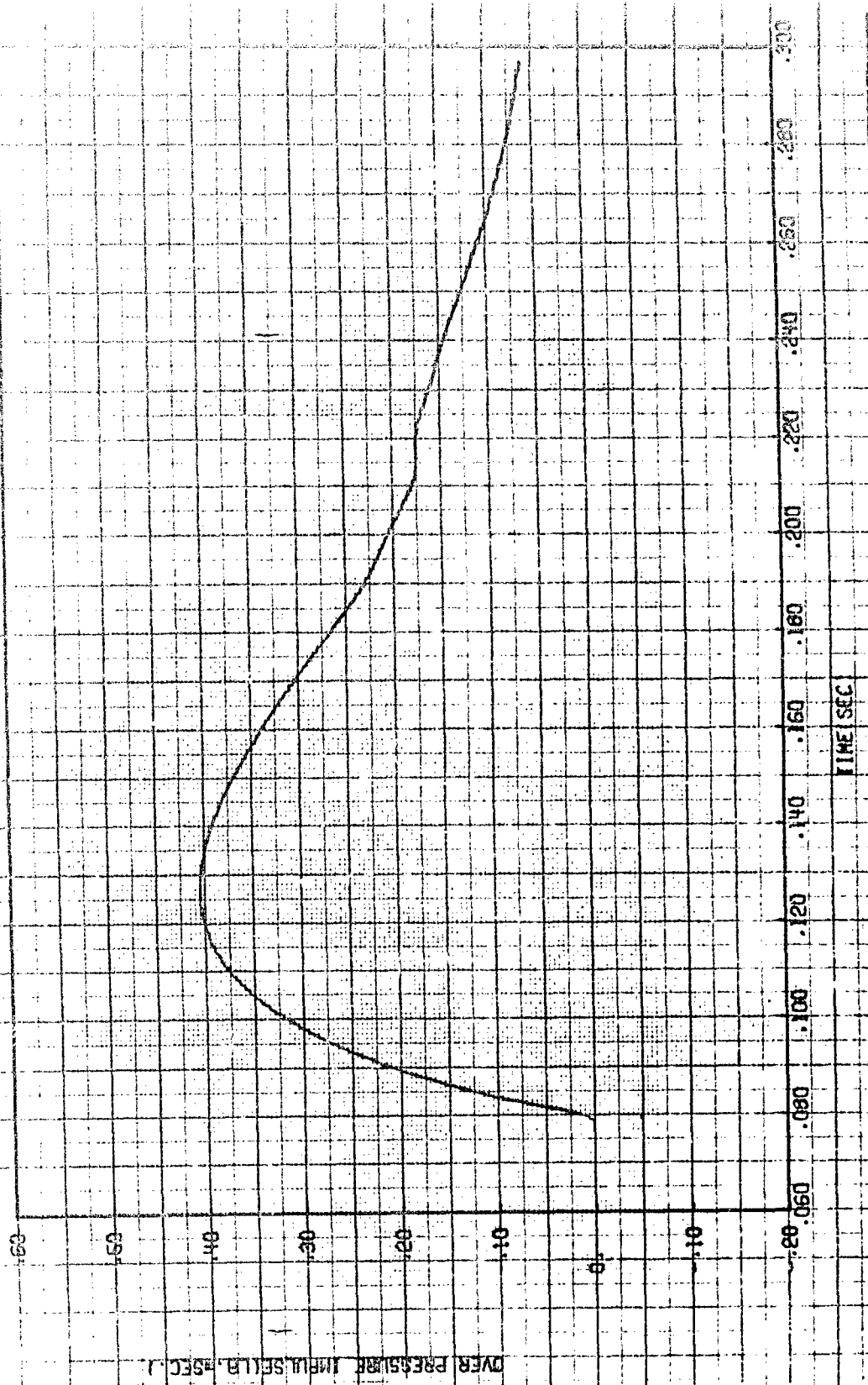
TIME SEC



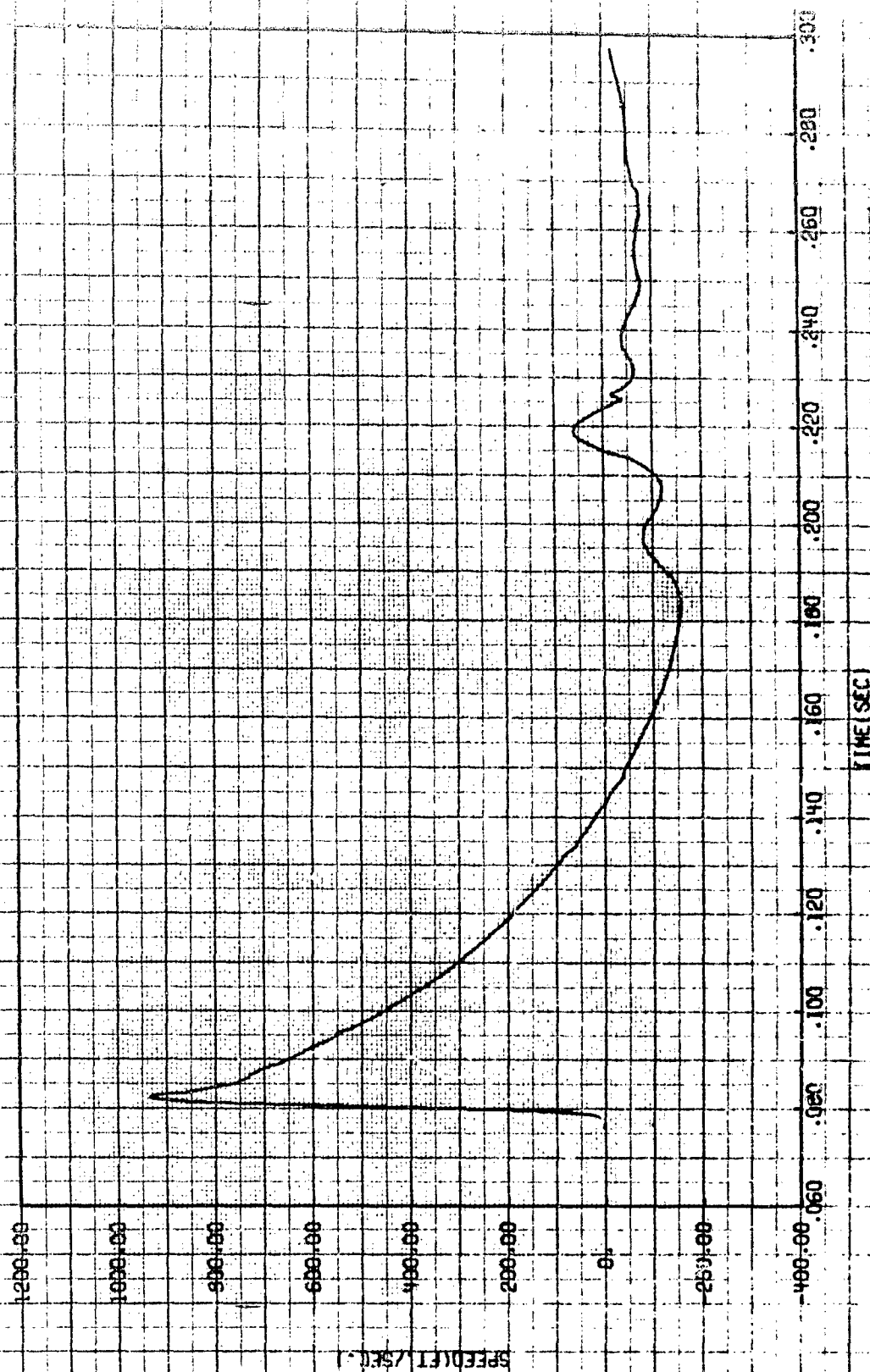
OVER PRESSURE VS TIME STATION NUMBER 15



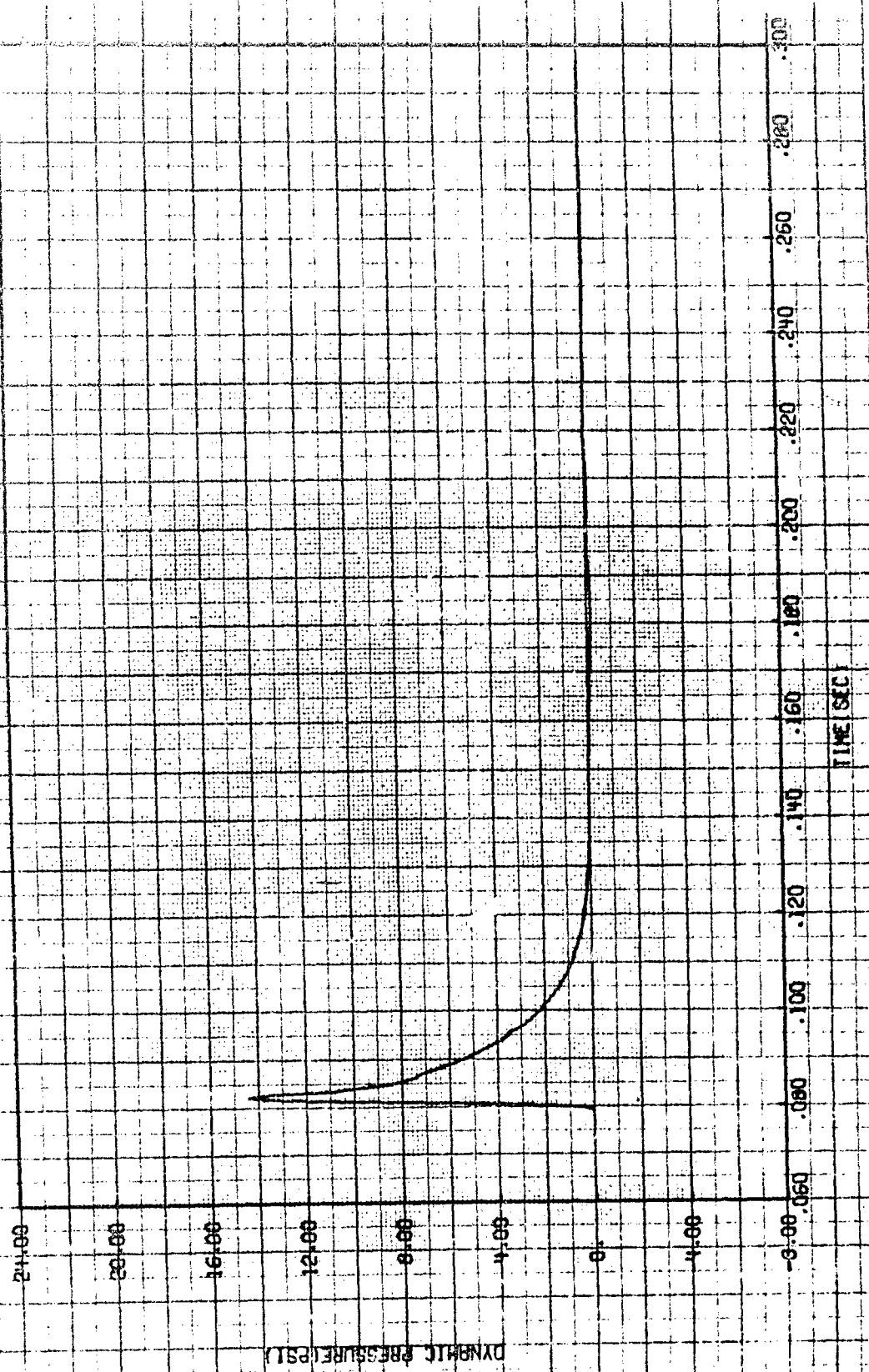
OVER PRESSURE INTRUSE VS TIME - STATION NUMBER 10



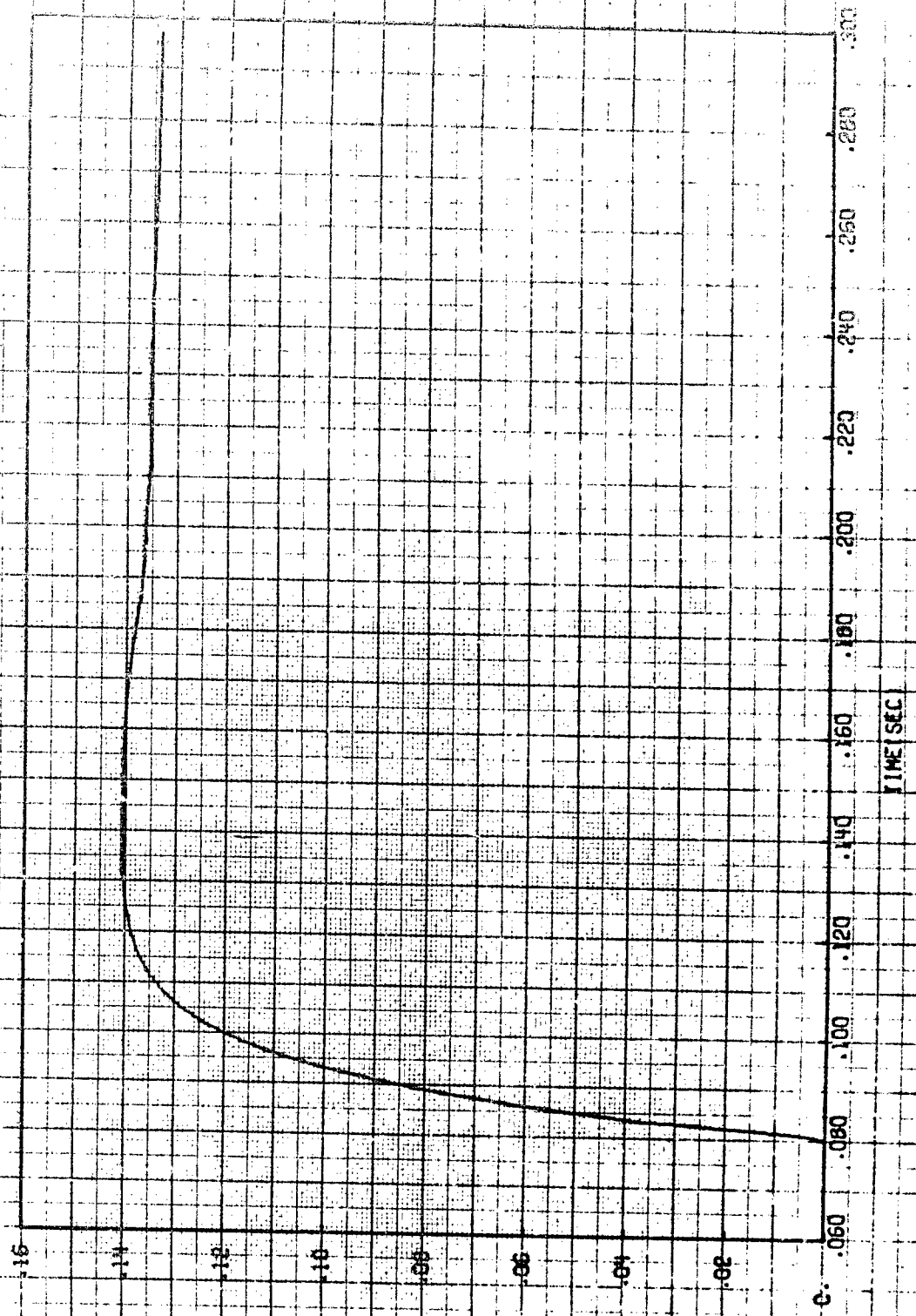
HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER IS



HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 15



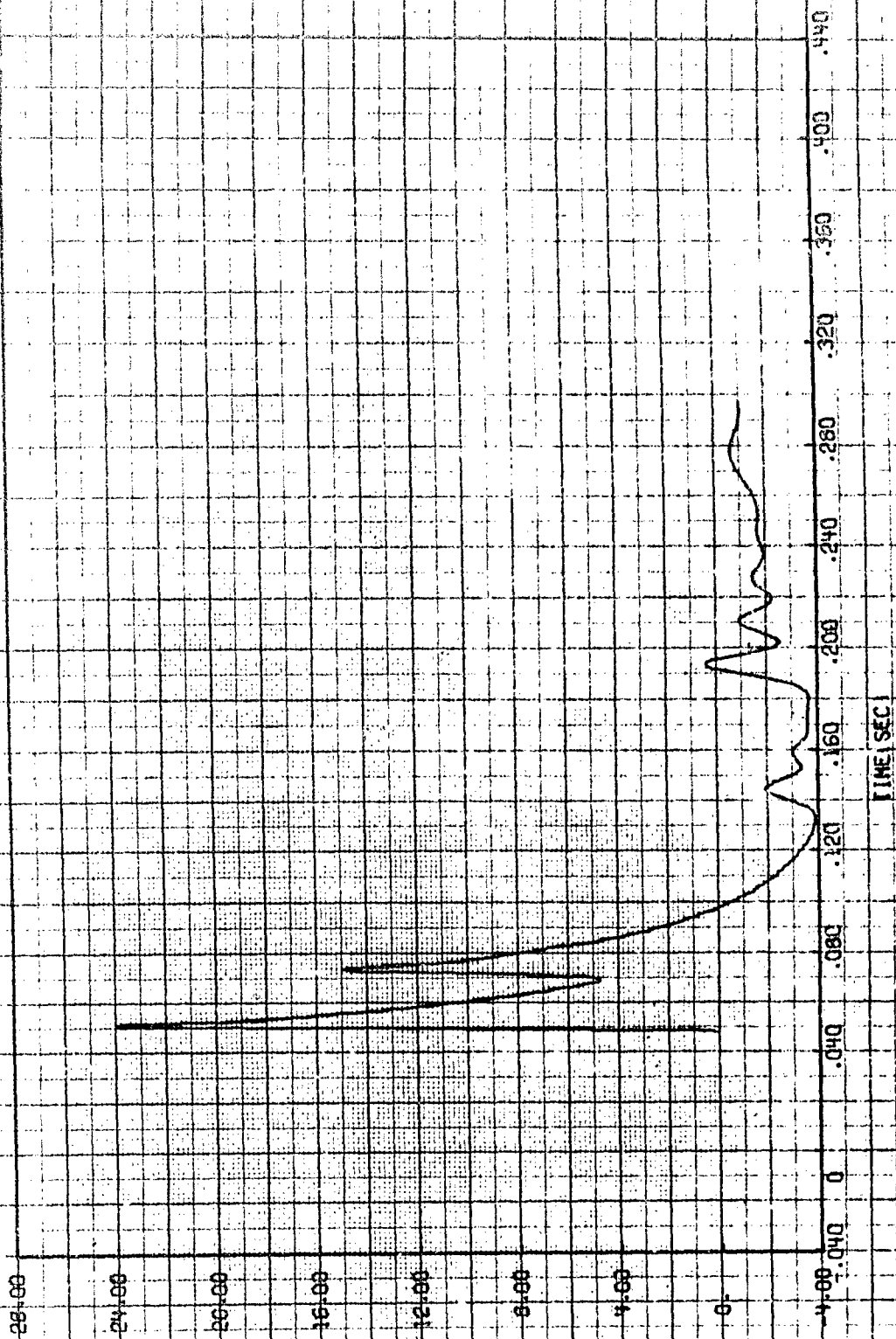
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION 15



DYNAMIC PRESSURE IMPULSE LBS./SQ. IN. SEC.

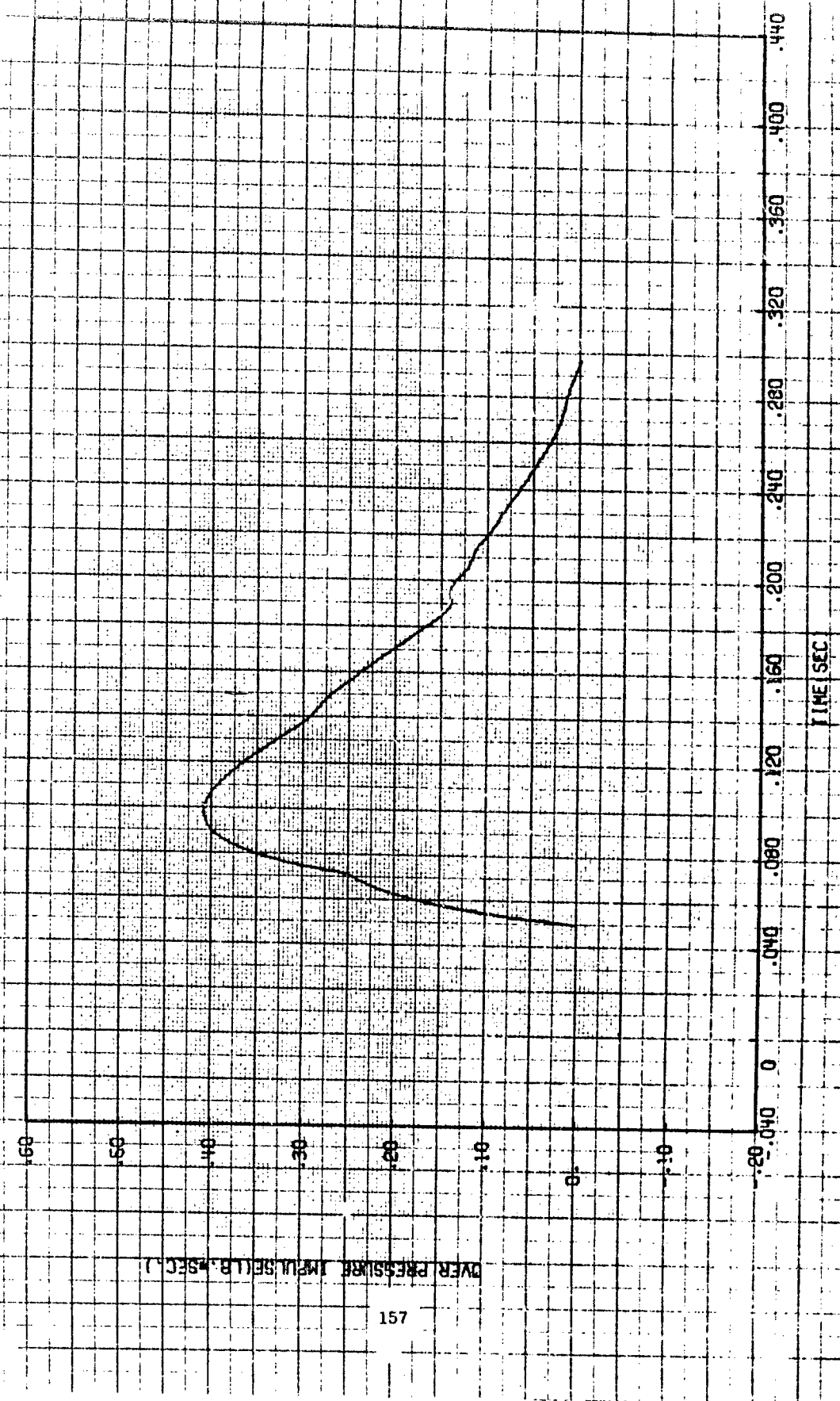
TIME SEC.

OVER-PRESSURE VS TIME STATION NUMBER 10

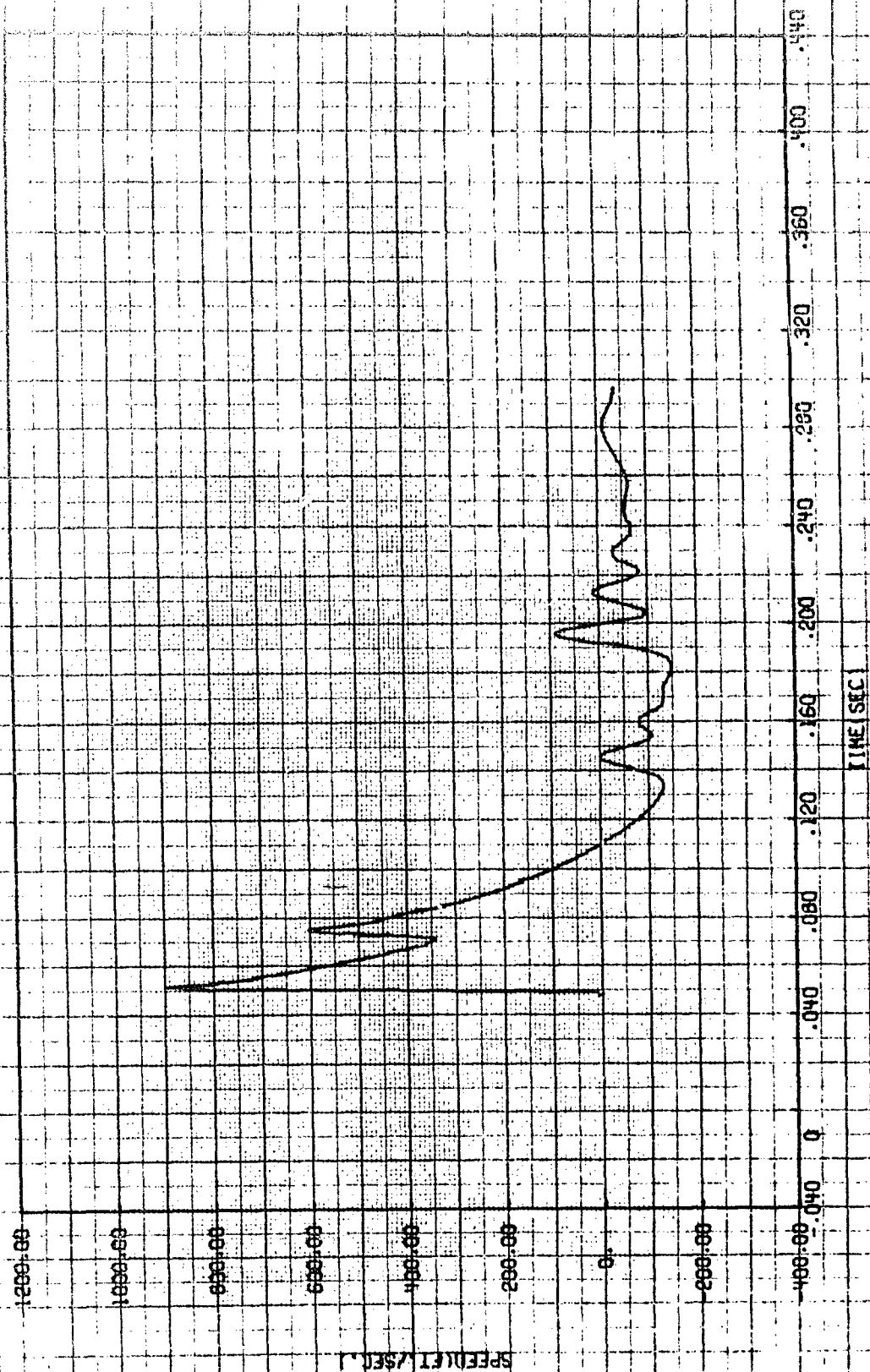


OVER-PRESSURE (PSI)

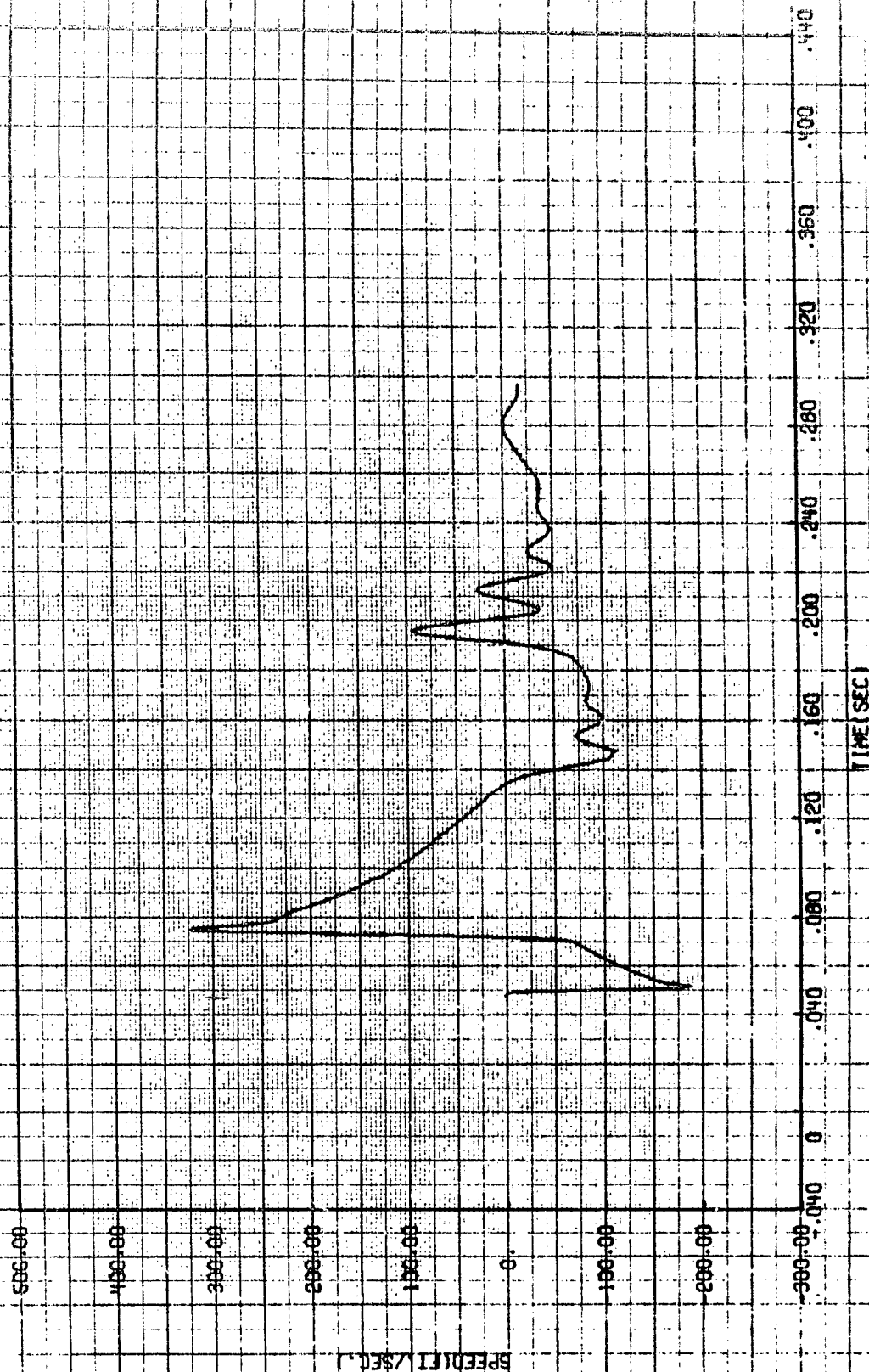
OVER PRESSURE IMPULSE VS TIME STATION NUMBER 18



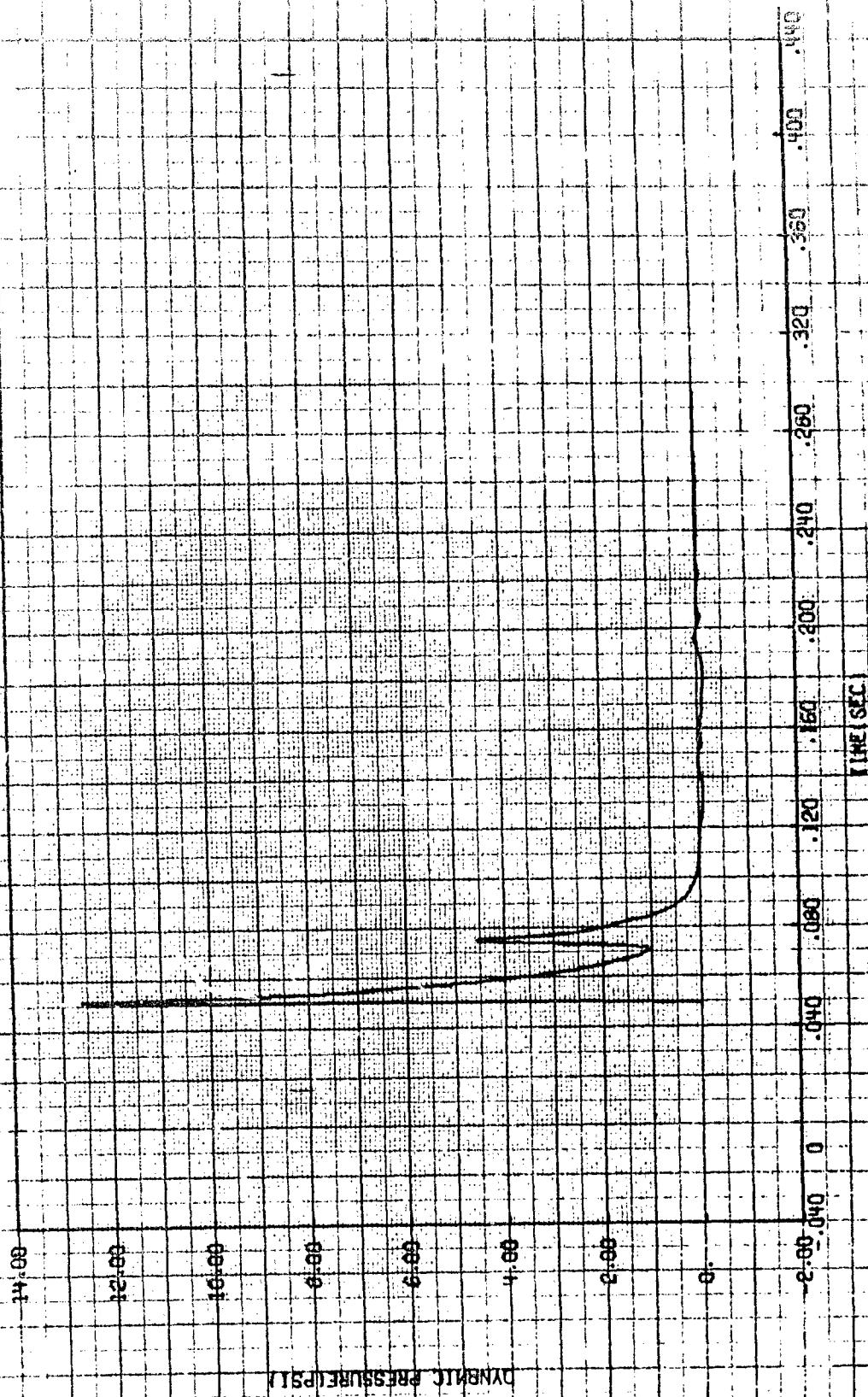
HORIZONTAL COMPONENT VELOCITY VS TIME STATION KOKEN 15



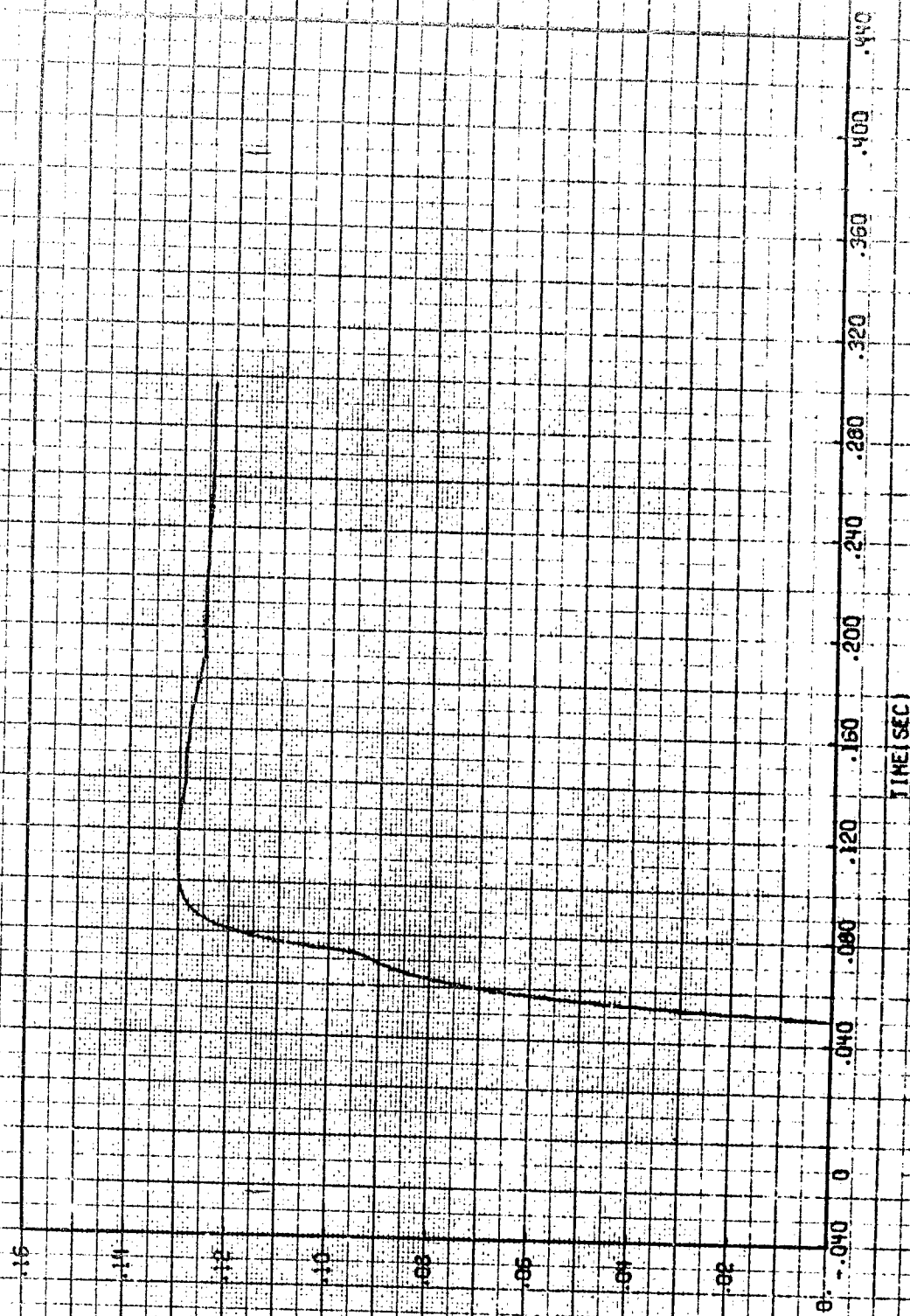
VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 15



HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 10

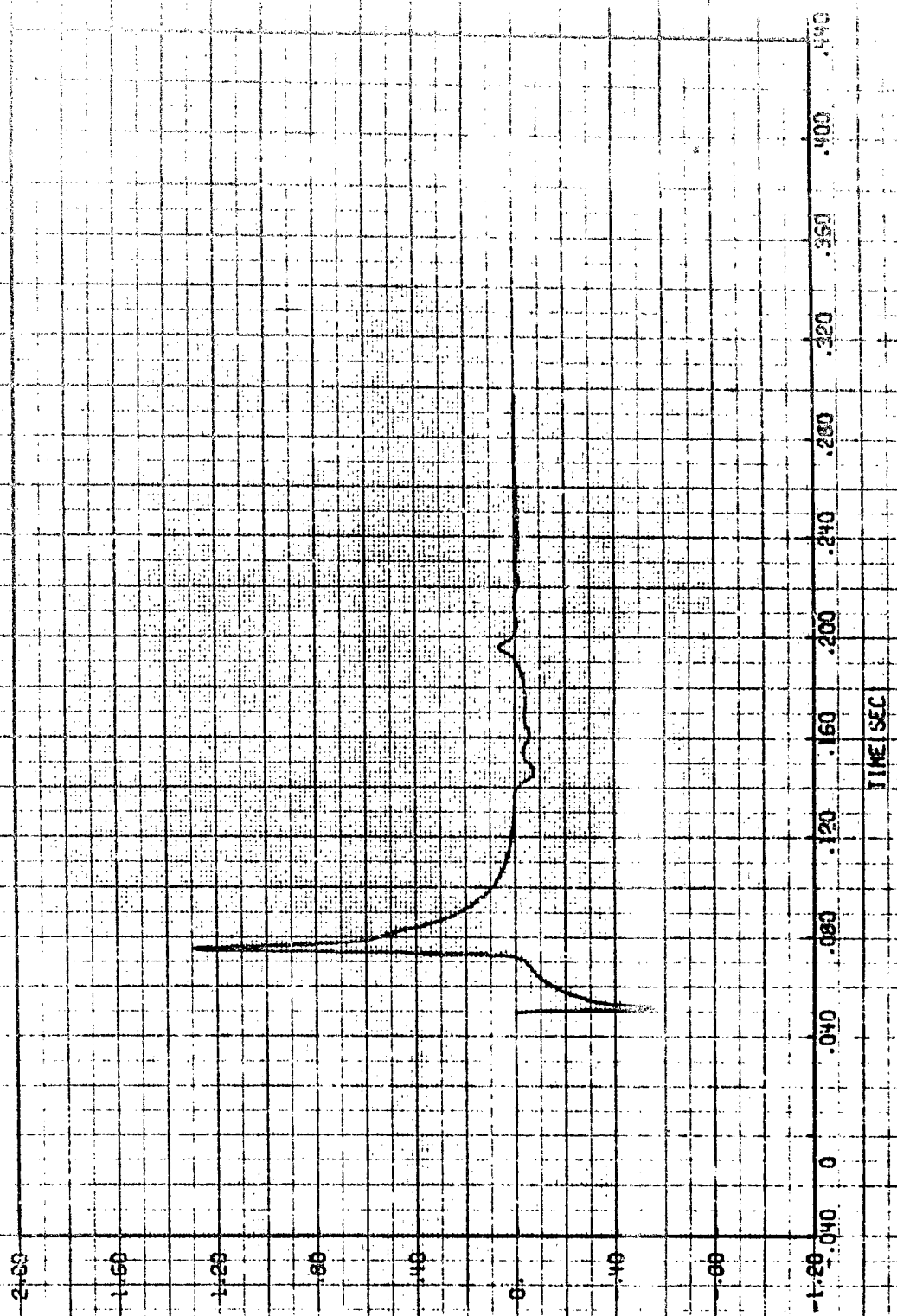


HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 10



DYNAMIC PRESSURE IMPULSE LBS/SEC. 2

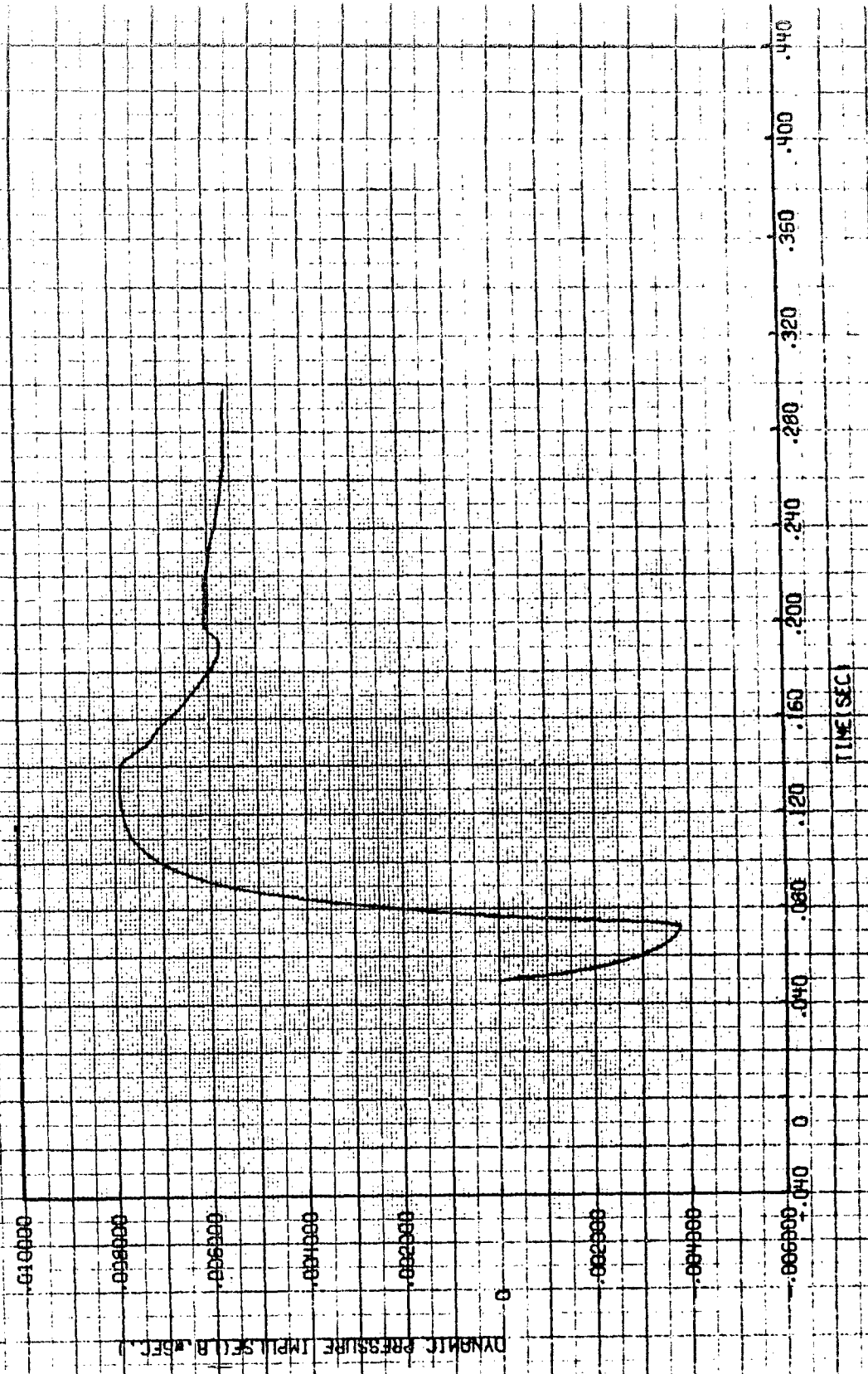
VERTICAL DYNAMIC PRESSURE VS TIME - SPT 1000 INCHES - 10

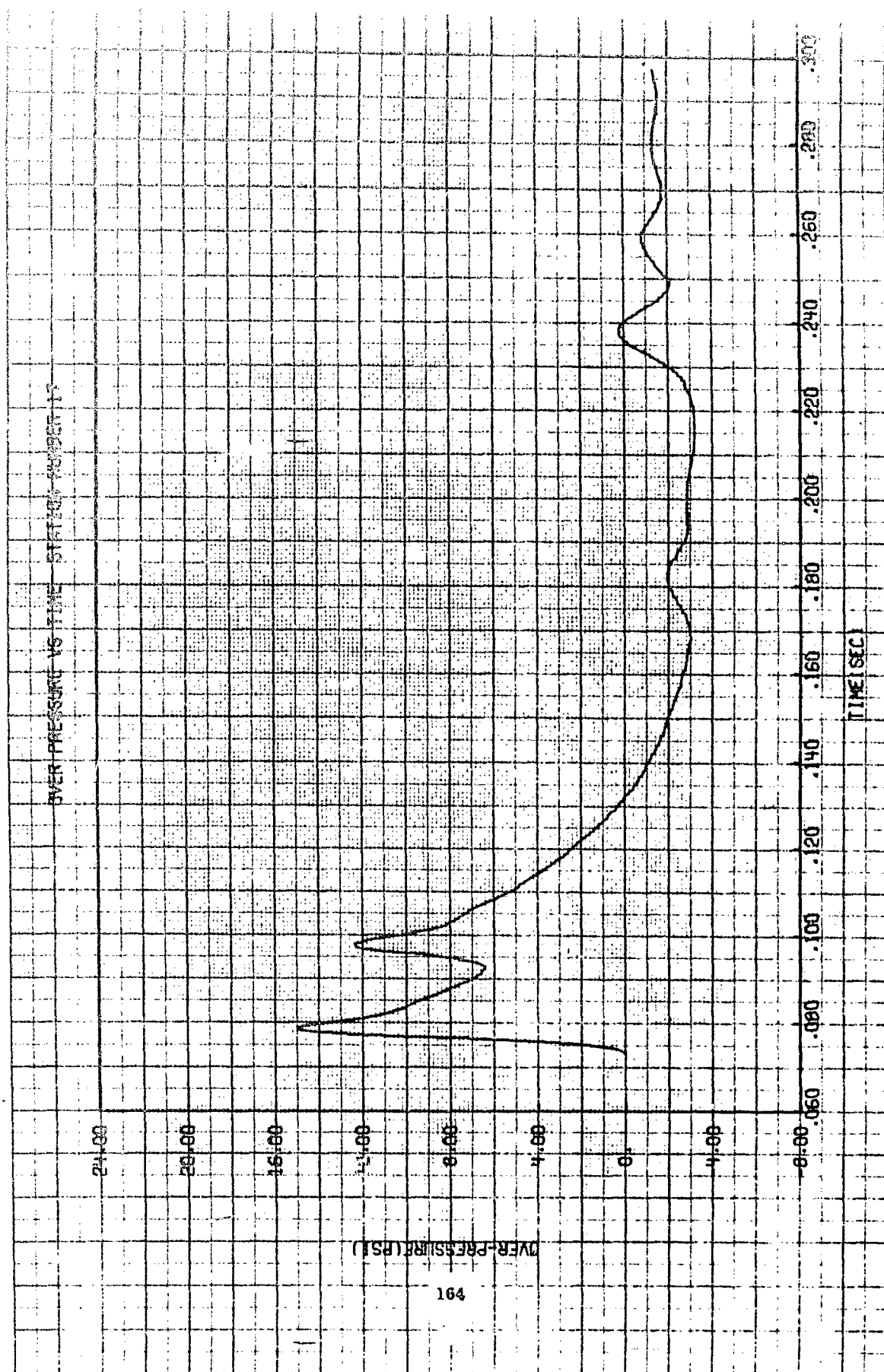


DYNAMIC PRESSURE (PSI)

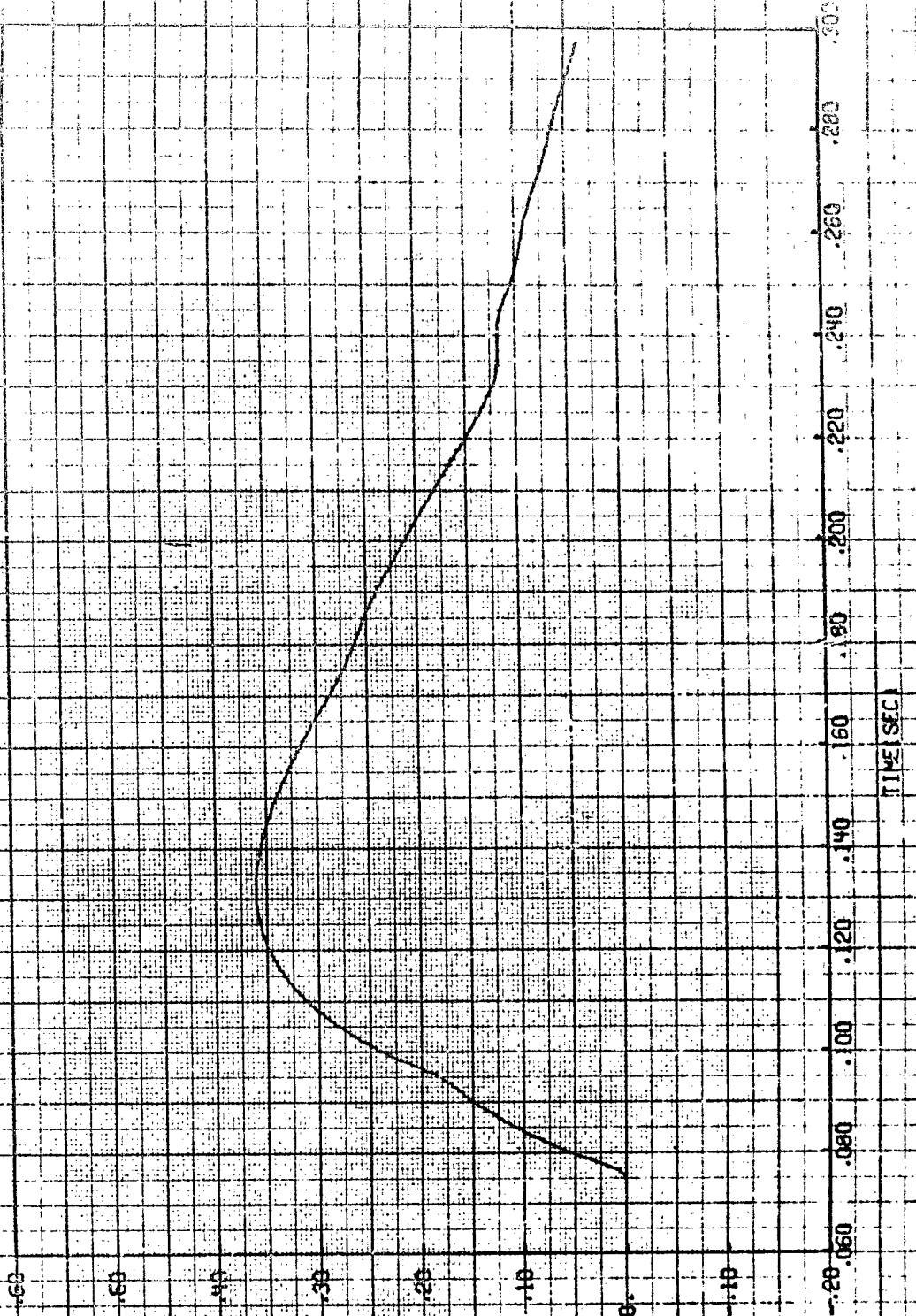
TIME (SEC)

VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER IS





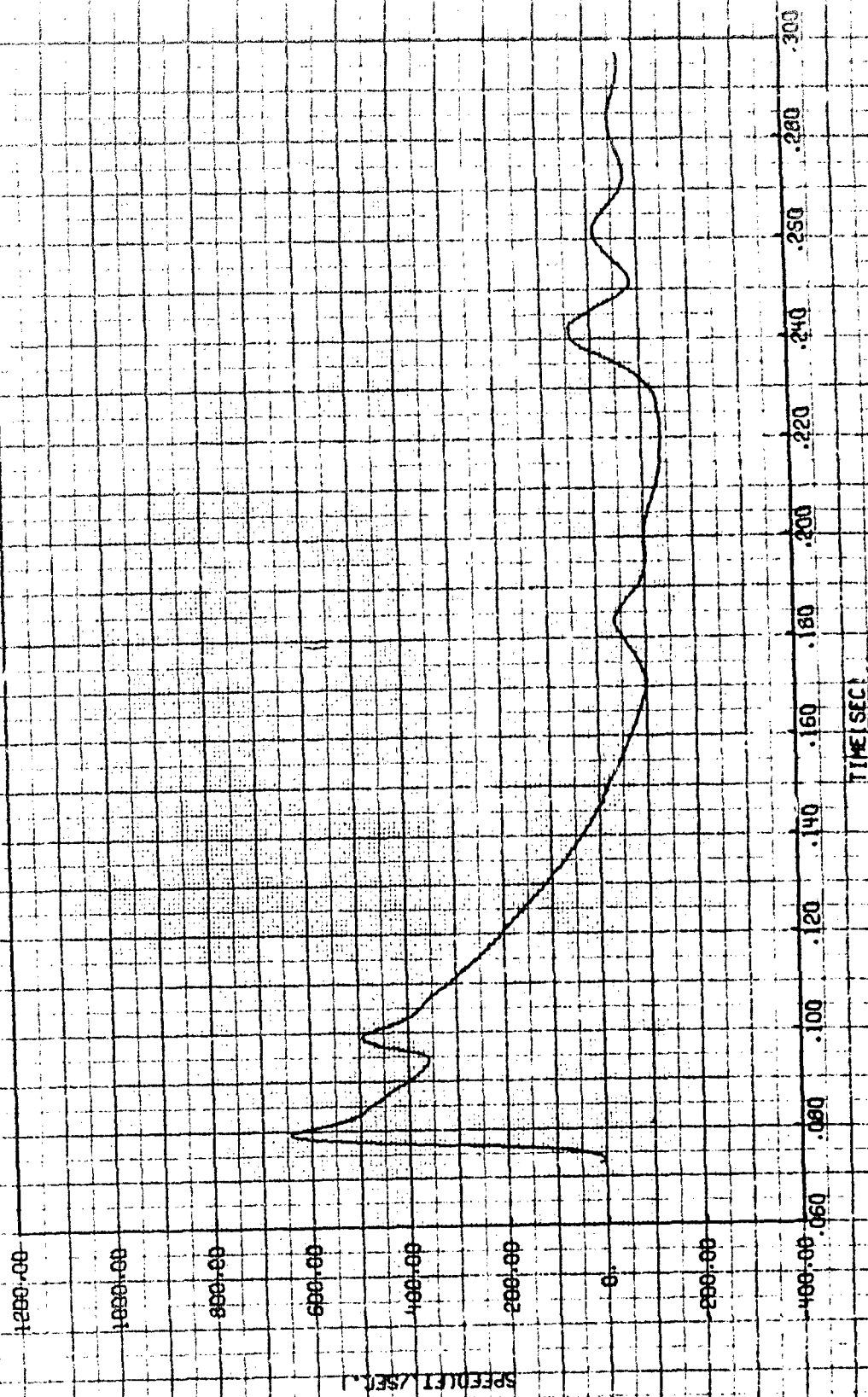
OVER PRESSURE IMPULSE VS TIME - STATION 17



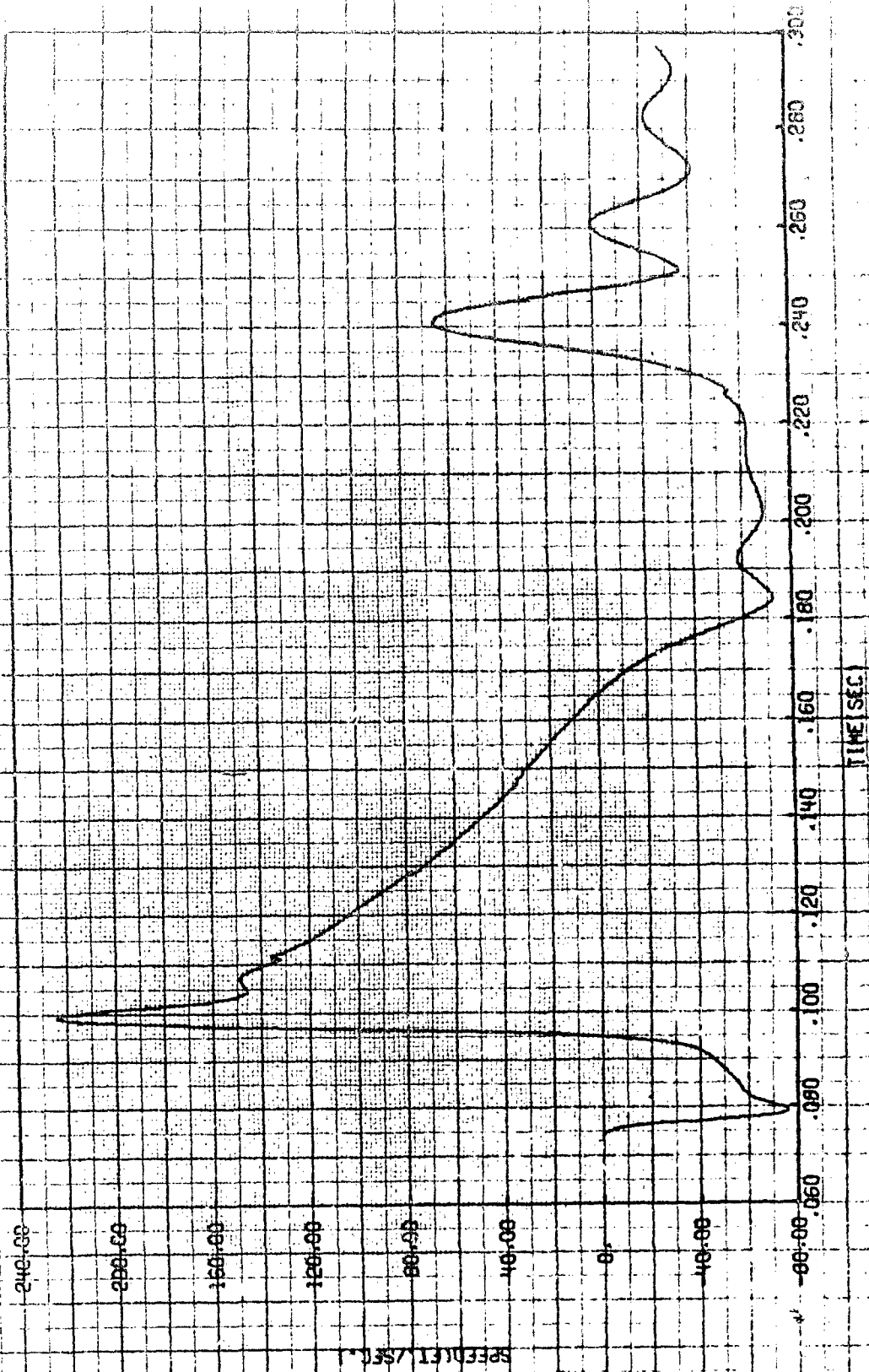
OVER PRESSURE IMPULSE (LBS/SEC)

TIME (SEC)

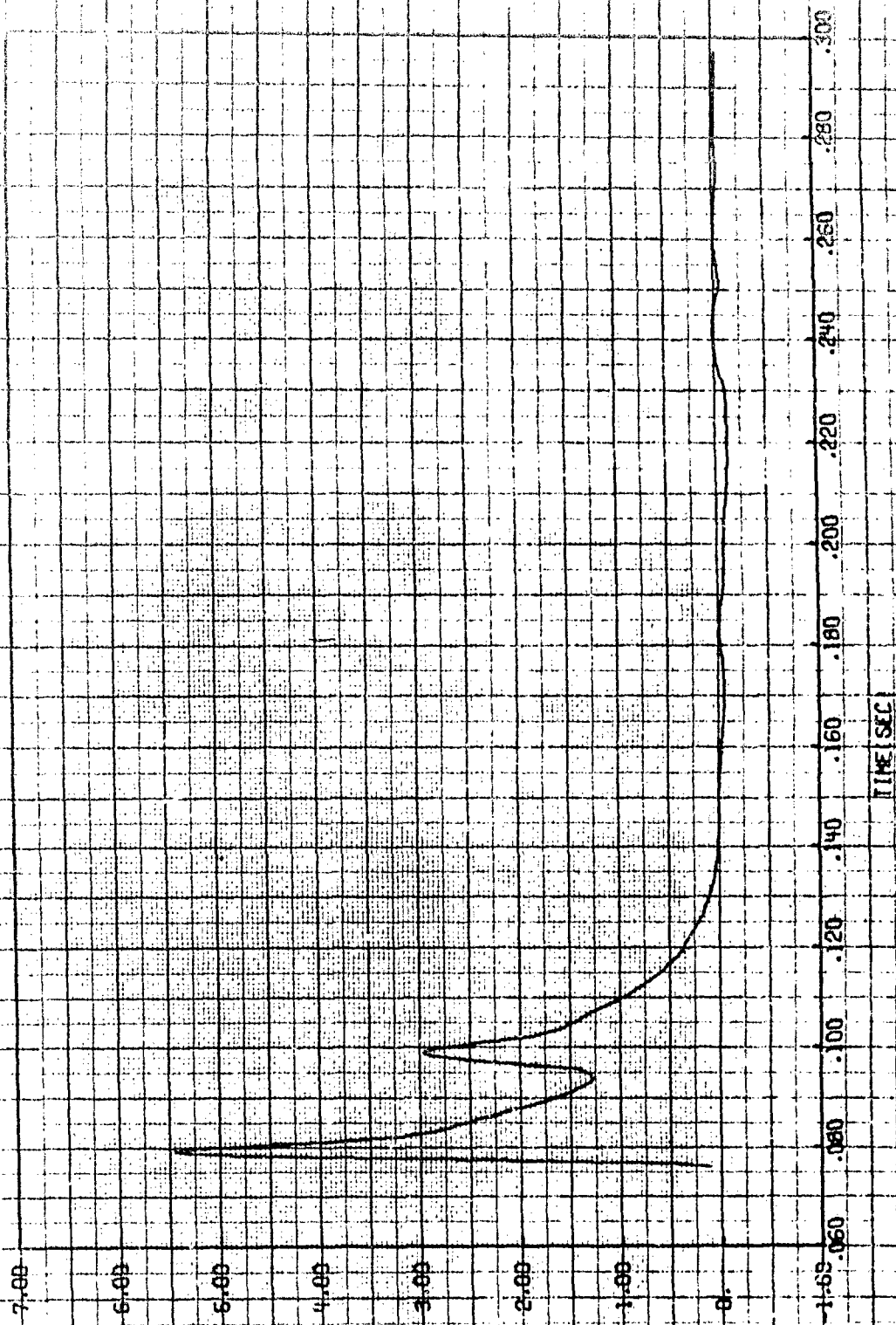
HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 17



VERTICAL COMPONENT VELOCITY VS TIME STARTING FROM 17



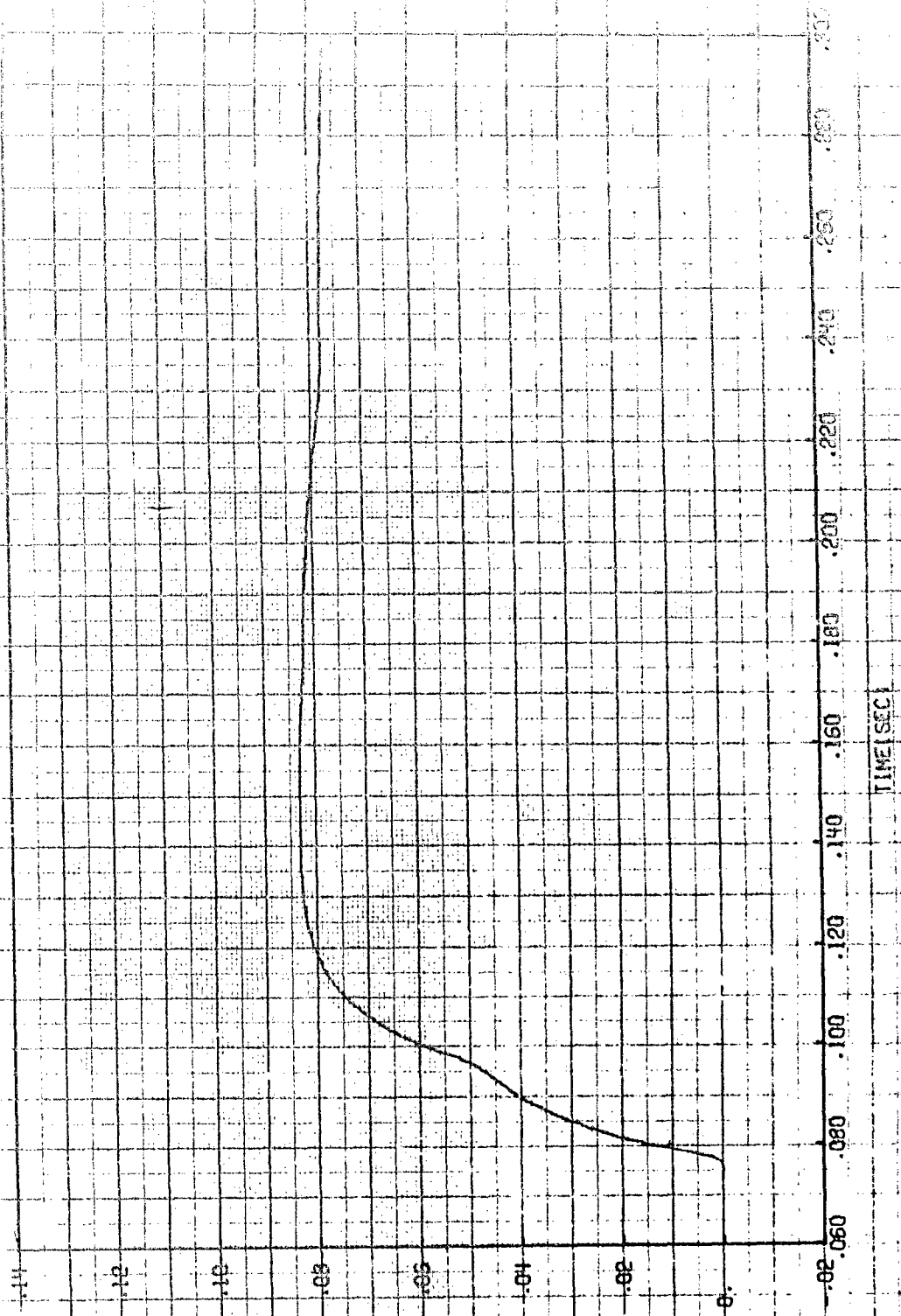
HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 19



DYNAMIC PRESSURE (PSI)

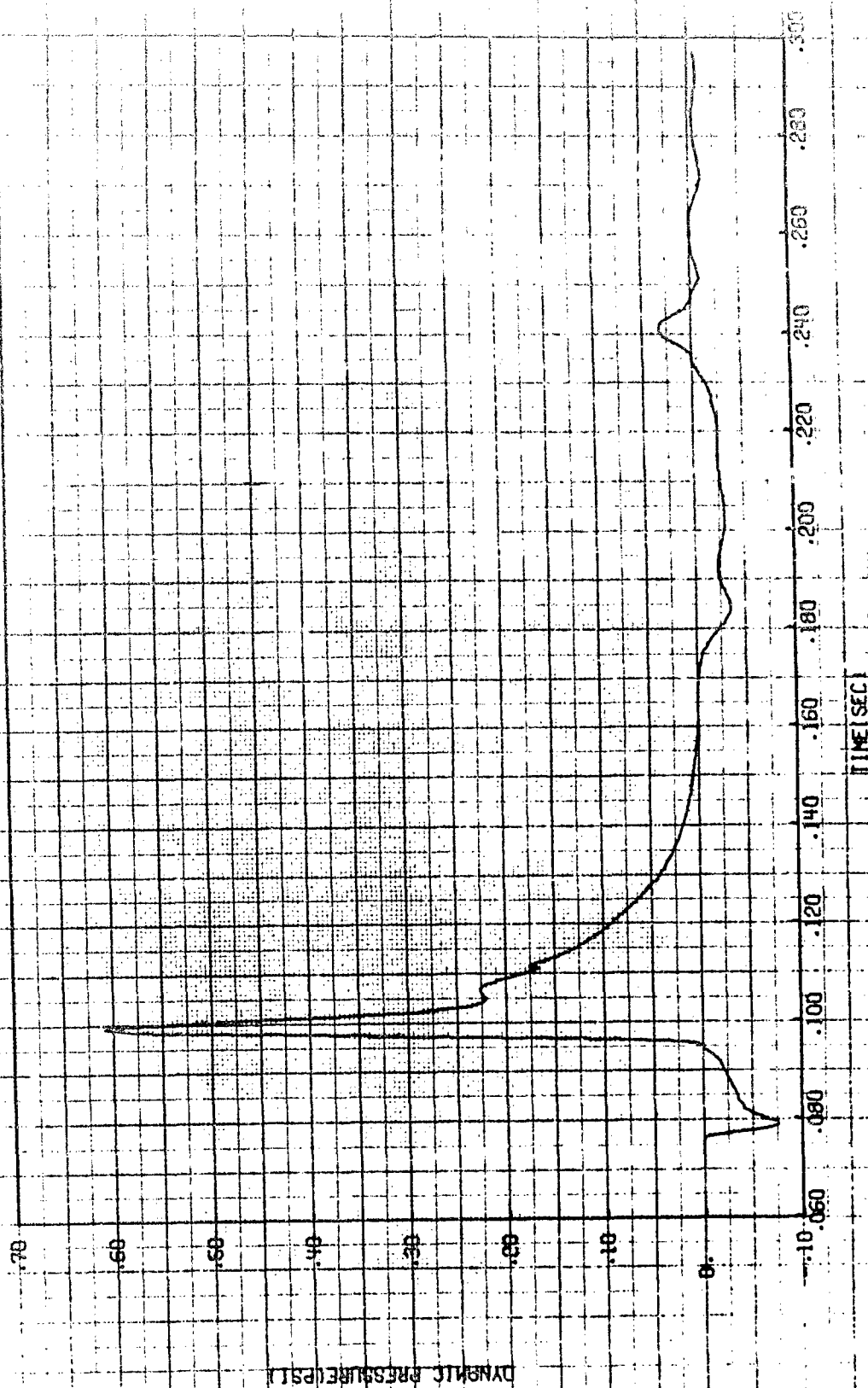
TIME (SEC)

HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME - STATION 1000000-10

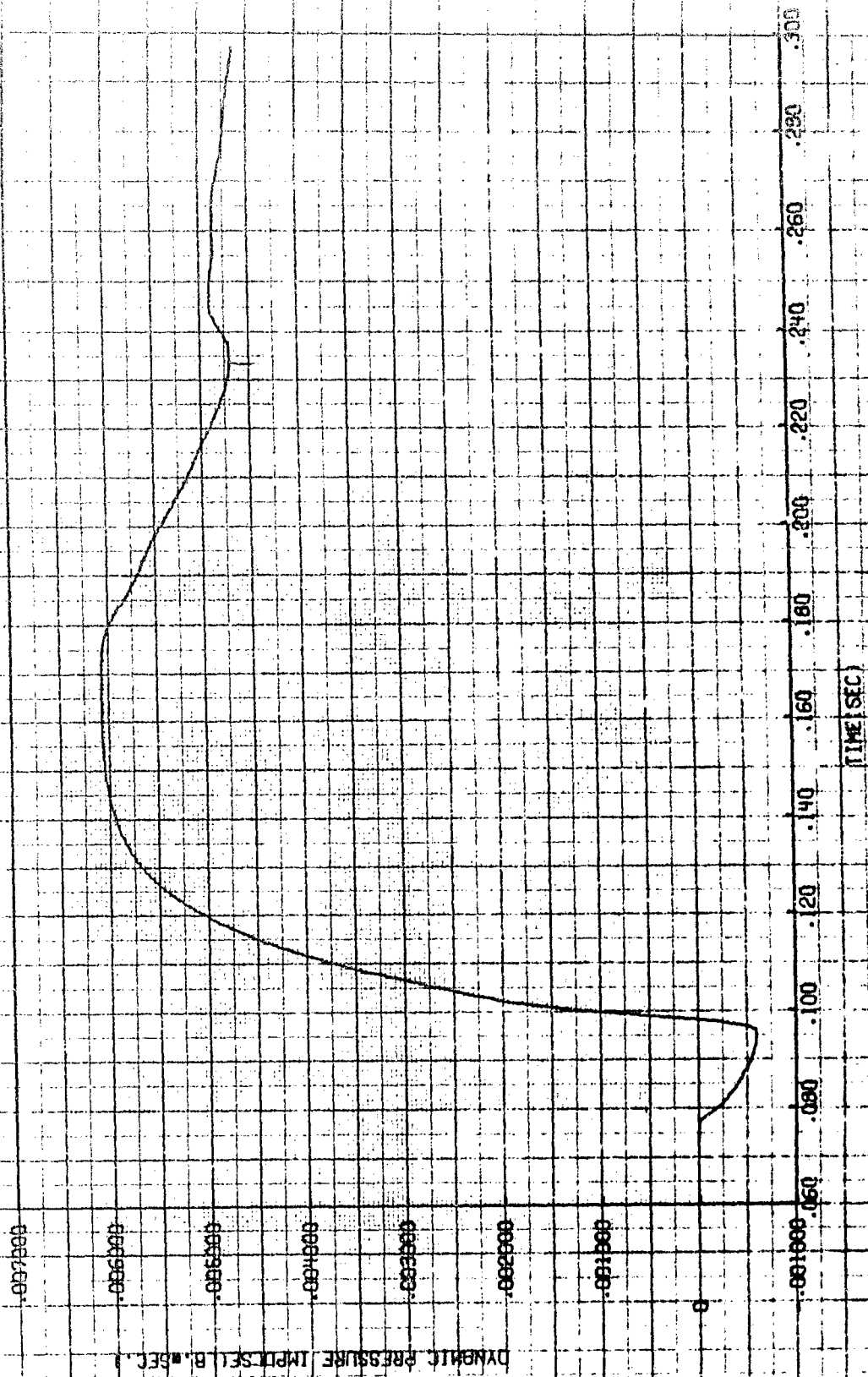


DYNAMIC PRESSURE IMPULSE (PSI-SEC)

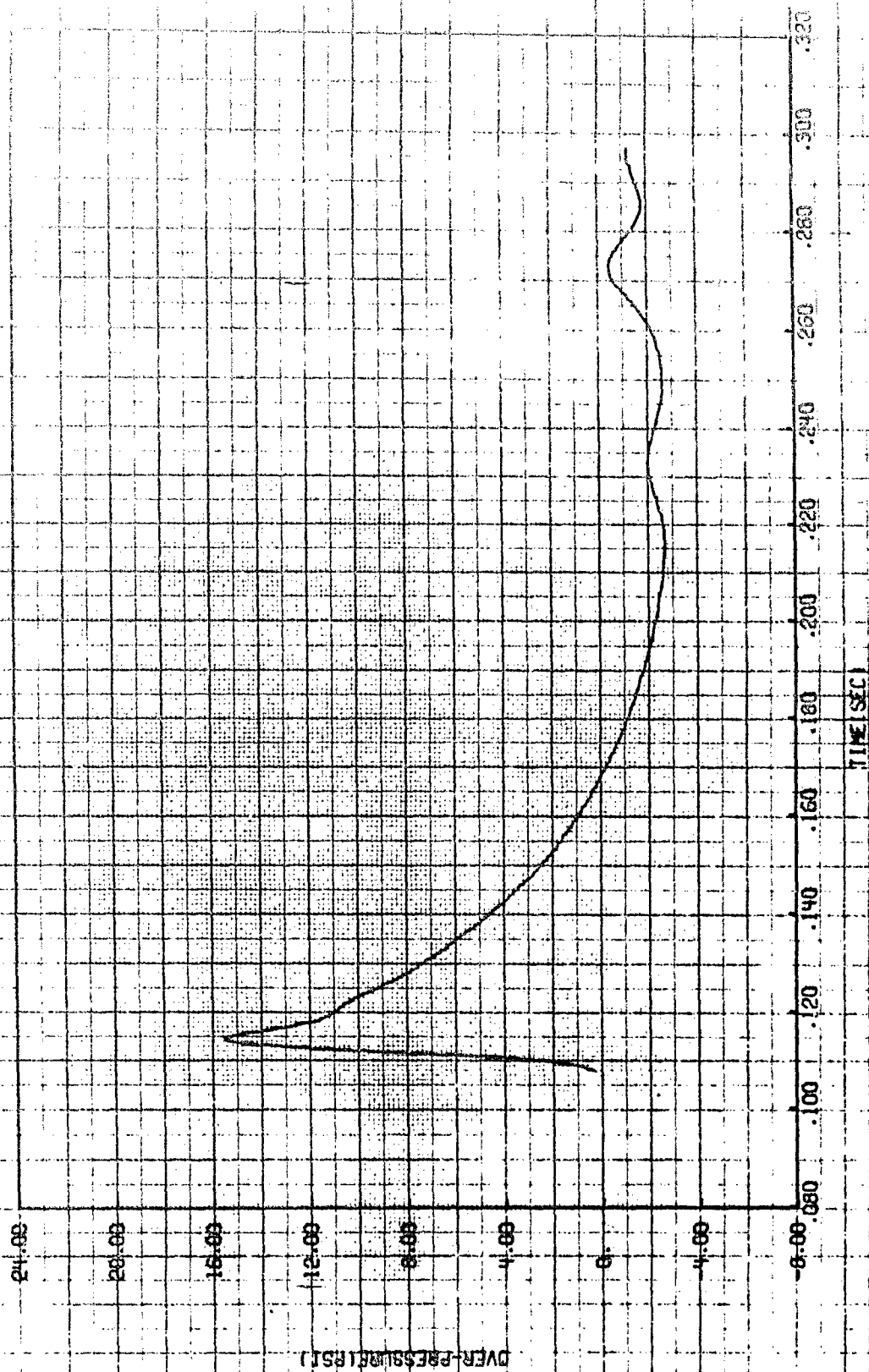
VERTICAL DYNAMIC PRESSURE VS TIME - STATION NUMBER 17



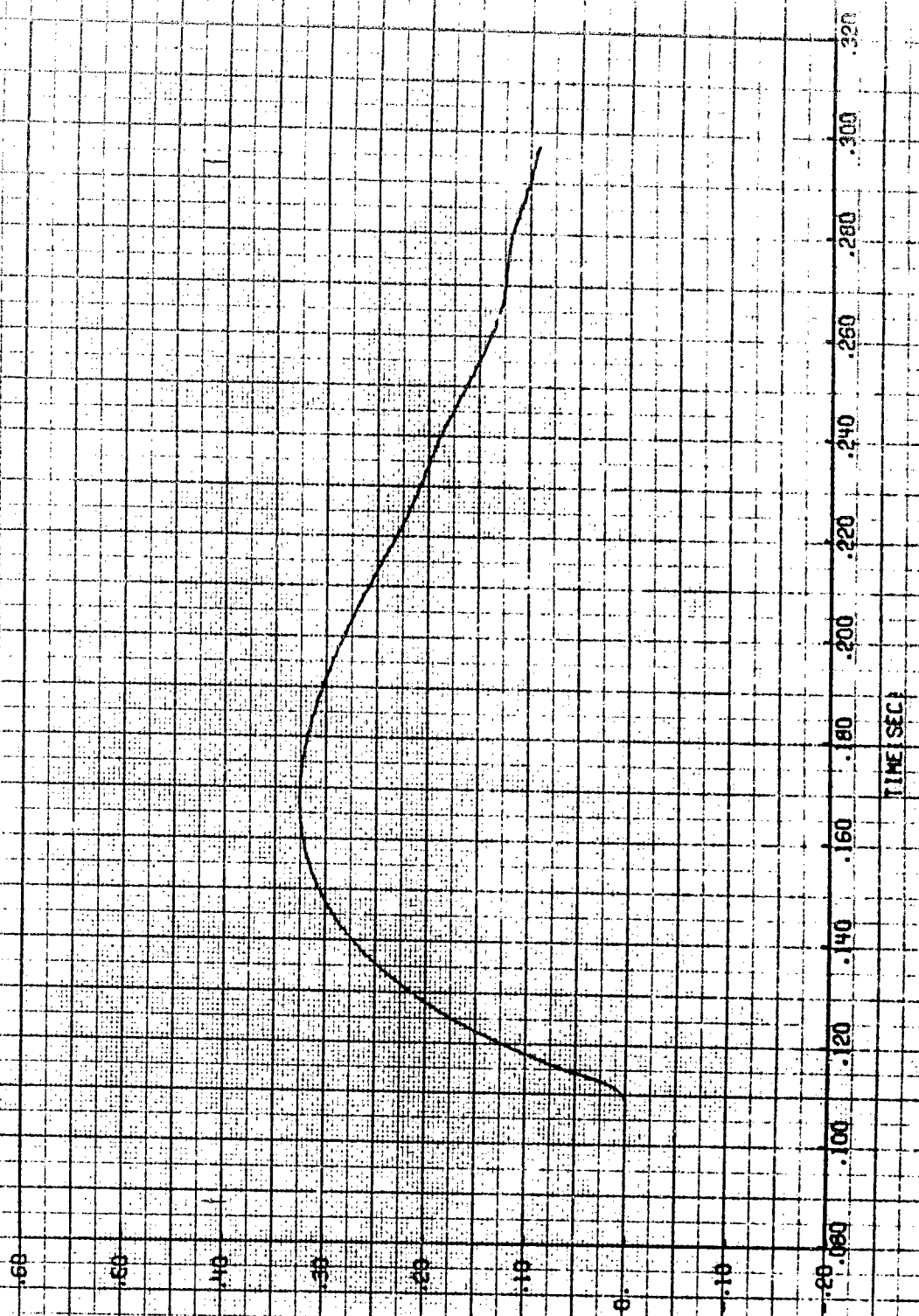
VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 15



OVER PRESSURE VS TIME STATION NUMBER 10

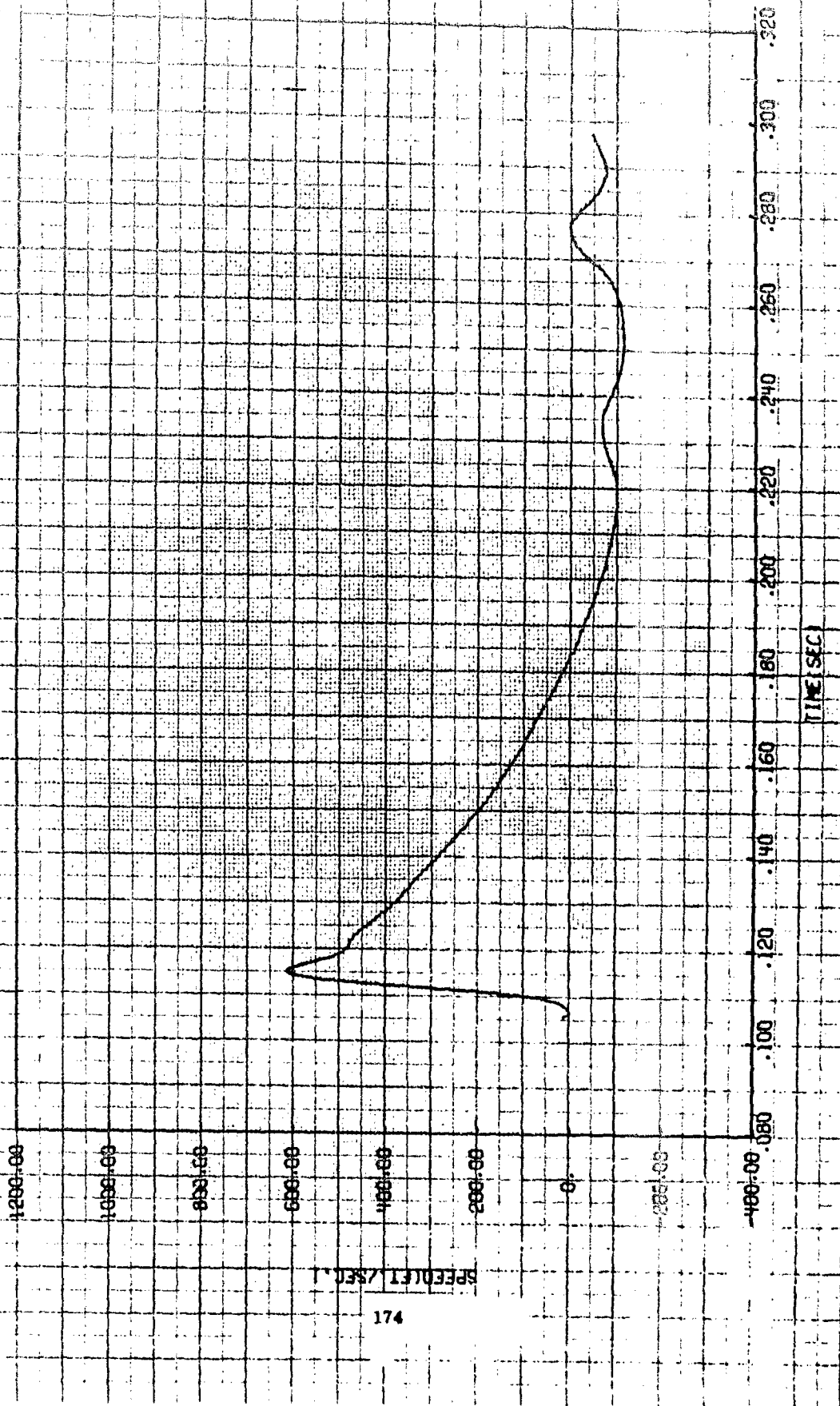


OVER PRESSURE IMPULSE VS TIME STATION NUMBER 12

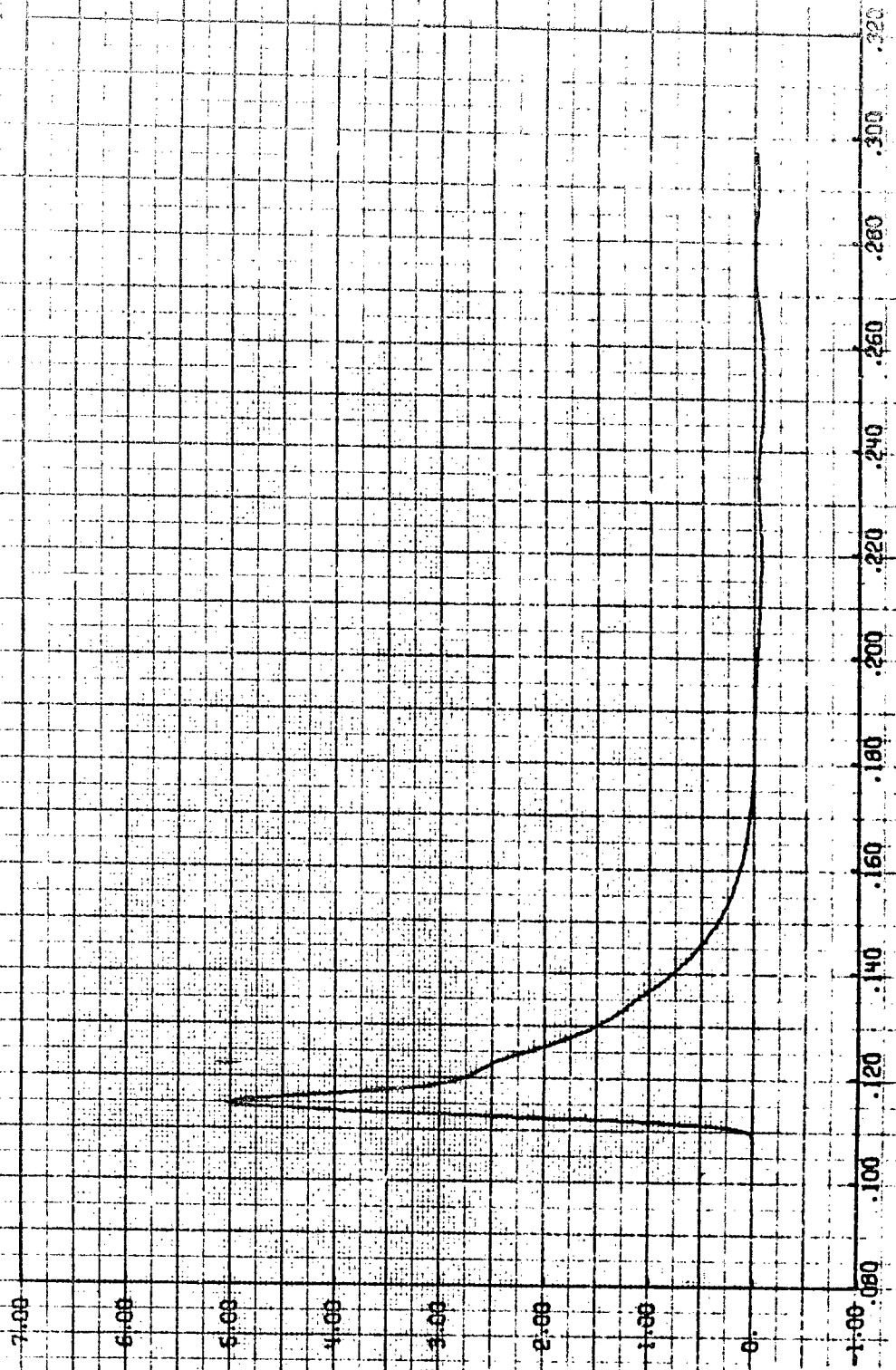


OVER PRESSURE IMPULSE (LBS./SQ. IN. SEC.)

HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 10



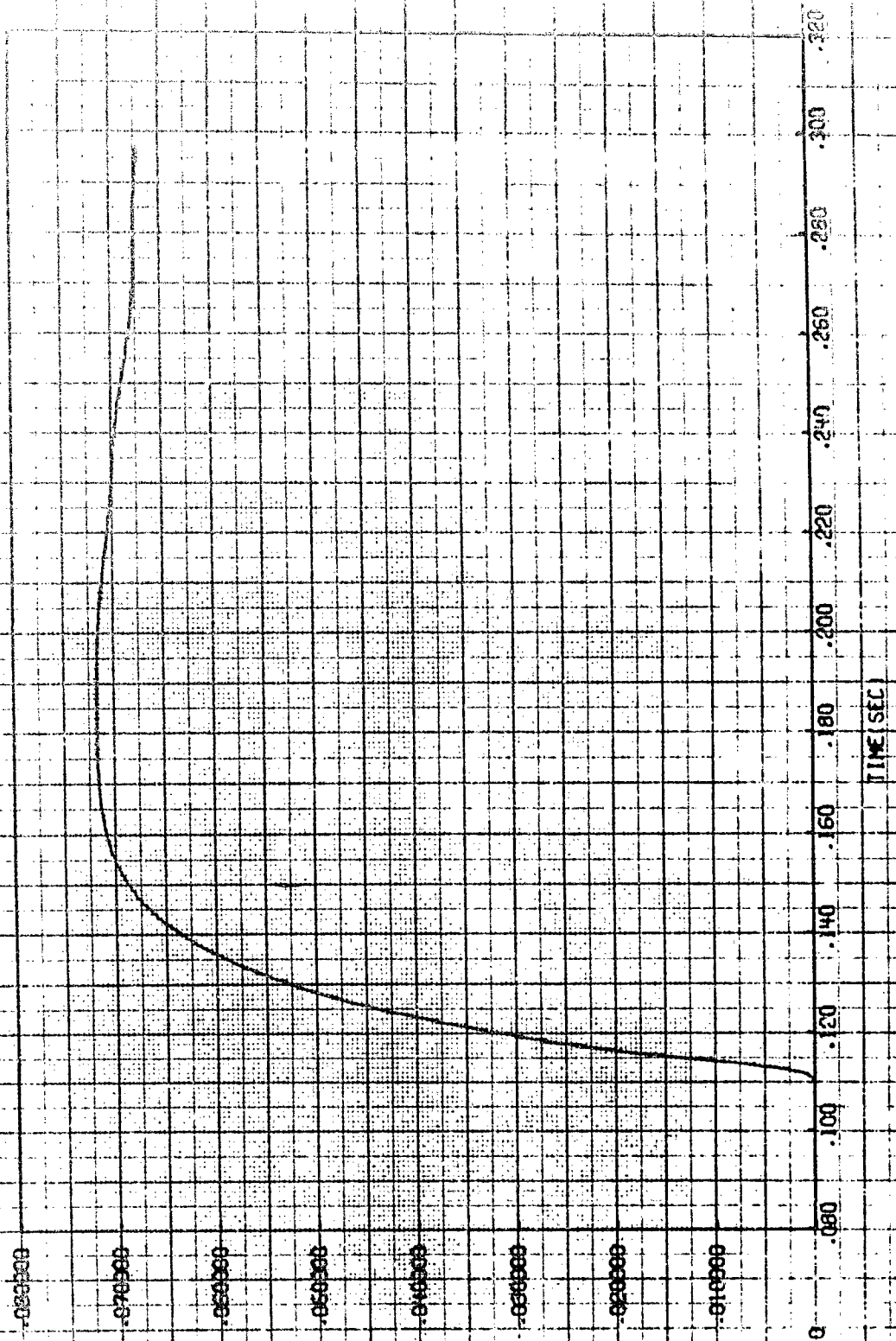
HORIZONTAL DYNAMIC PRESSURE VS TIME - STATION NUMBER 10



DYNAMIC PRESSURE (PSI)

TIME (SEC)

HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME - STATION NUMBER 10



OVER PRESSURE VS TIME - STATION NUMBER 15

12.00

10.00

8.00

6.00

4.00

2.00

0

2.00

4.00

OVER PRESSURE (PSI)

177

.320

.300

.280

.260

.240

.220

.200

.180

.160

.140

.120

.100

.080

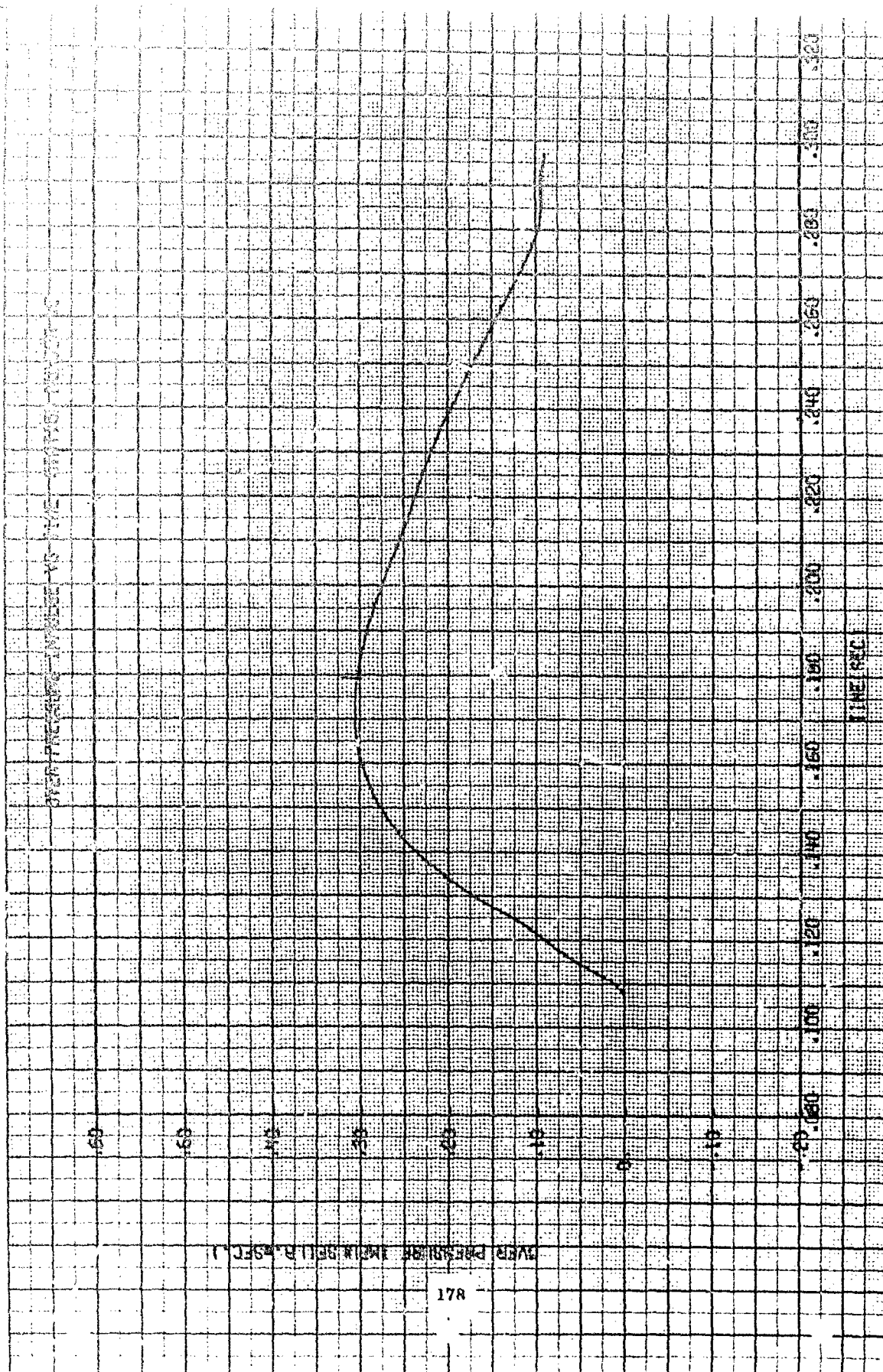
.060

.040

.020

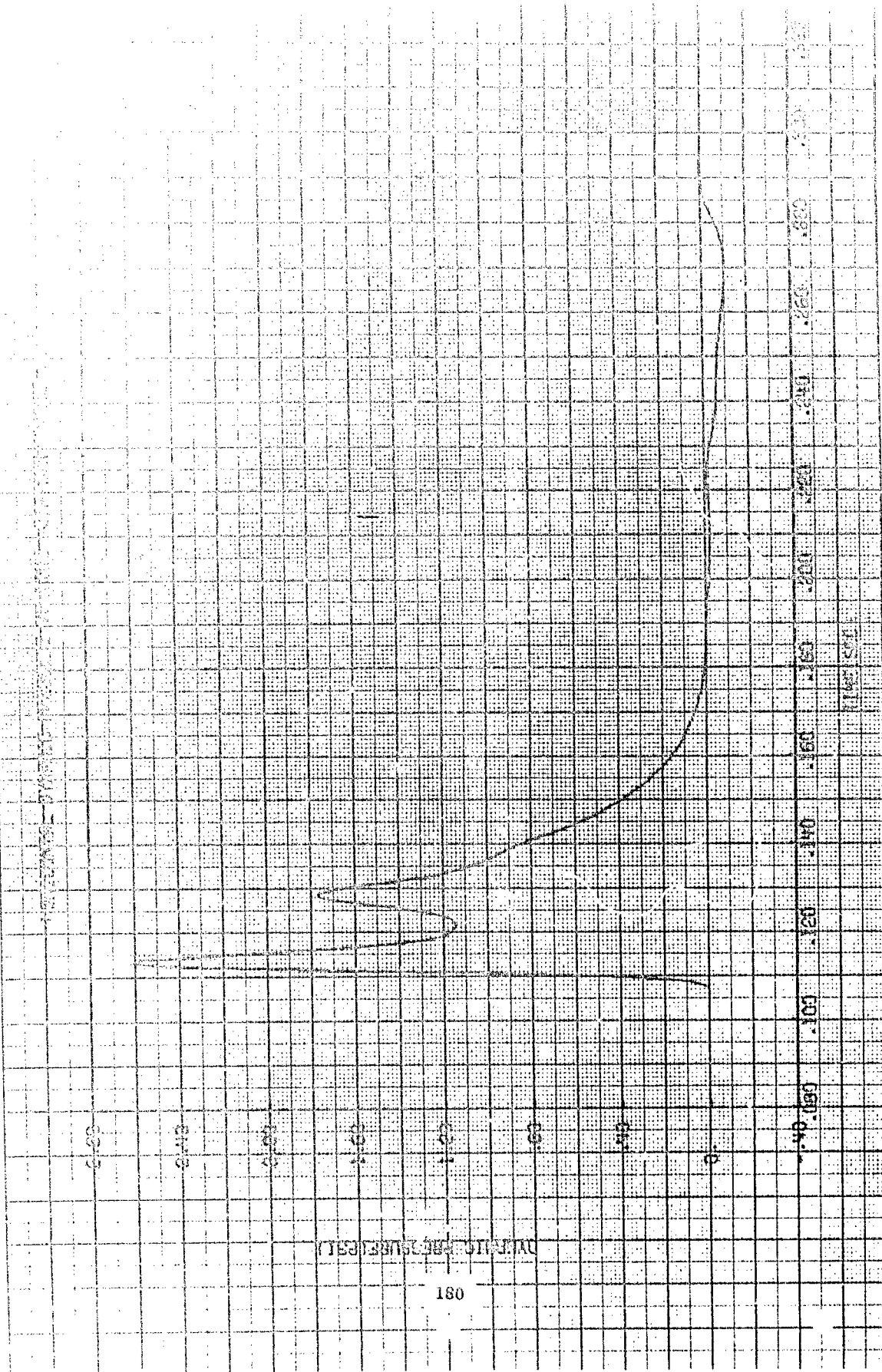
0

TIME SEC



OVER PRESSURE INCHES

TIME SEC



HORIZONTAL DYNAMIC PRESSURE INCREASE VS TIME STATION NUMBER 10

0.070000

0.050000

0.030000

0.010000

0.000000

0.000000

0.000000

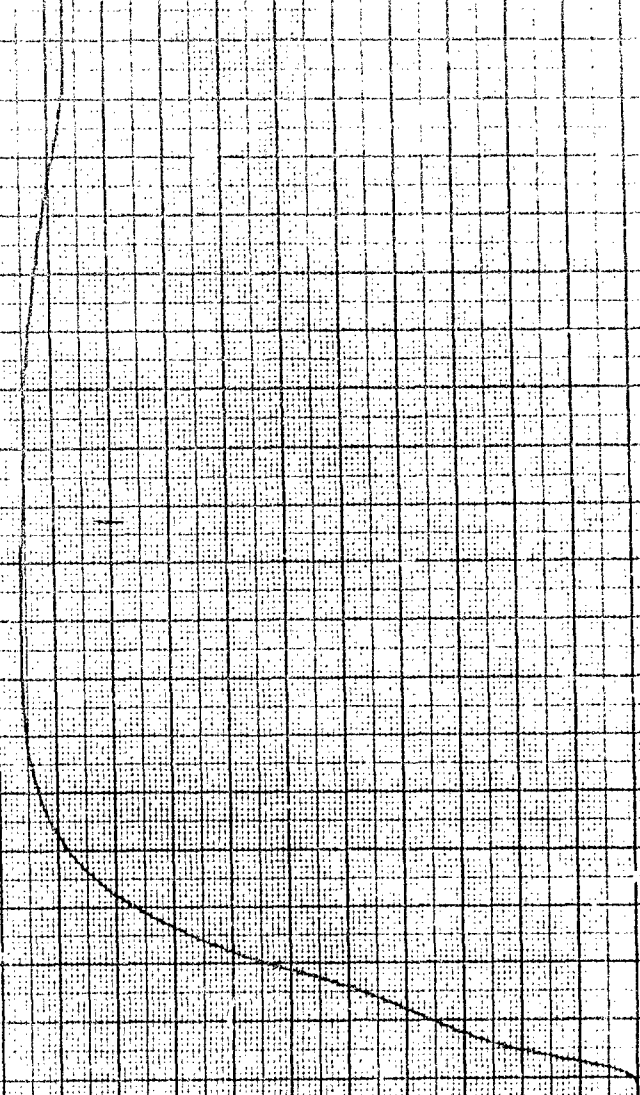
0

DYNAMIC PRESSURE INCREASE (PSF)

0.010000

TIME (SEC)

0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00



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SECTION III

THE METHANE CALCULATION

SAP Profiles

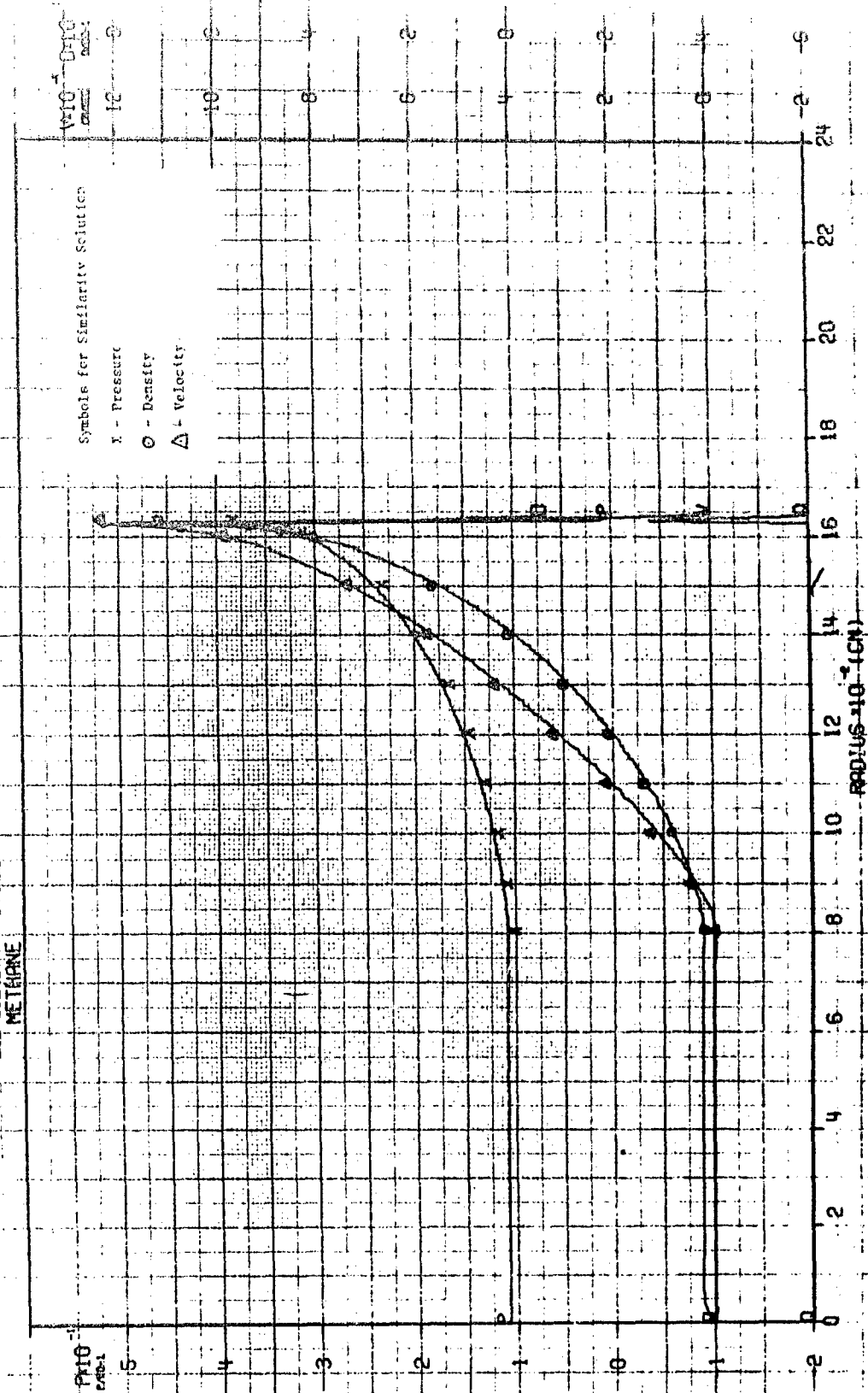
This part contains profiles of pressure, density and velocity as calculated by SAP for the methane detonation. This charge, a 1.5 to 1 molar mixture of oxygen and methane, was initially contained in a balloon of 55 ft radius. There are plots for 16 different times.

The first plot contains the profiles describing the flow field behind the detonation front in the methane. Unlike the TNT detonation ambient pressure (13.6 psi) is not negligible; therefore the similarity solution differs from the SAP calculation by approximately 5 percent as can be seen in the first figure. The similarity solution for the methane detonation using the following parameters: detonation velocity, 2.7522×10^5 cm/sec; loading density, 1.07197×10^{-3} gm/cm³; gamma = 1.2136.

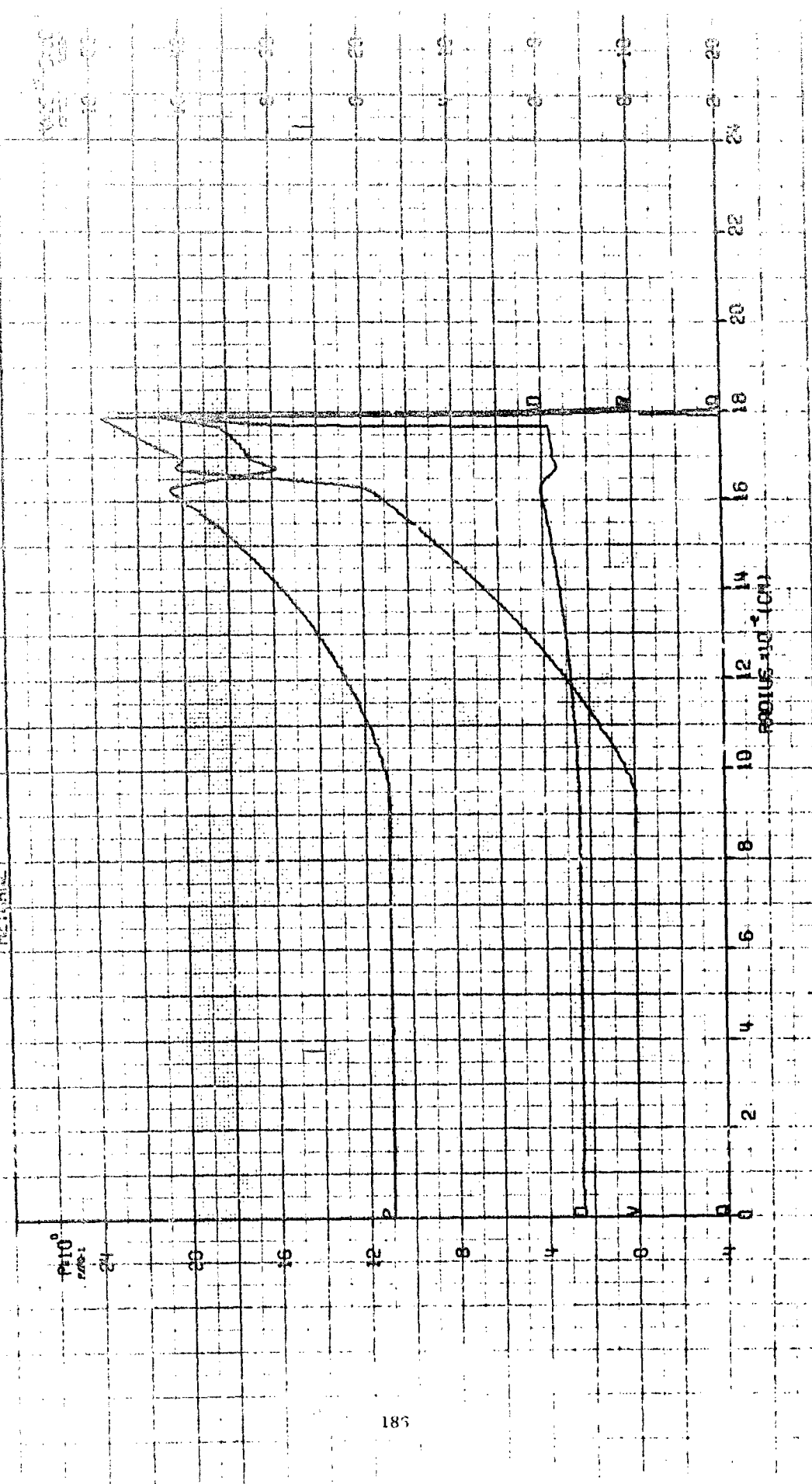
Succeeding plots show the convergence of the rarefaction wave on the origin, the formation and expansion of the free-air shock, and the formation and motion of secondary shocks.

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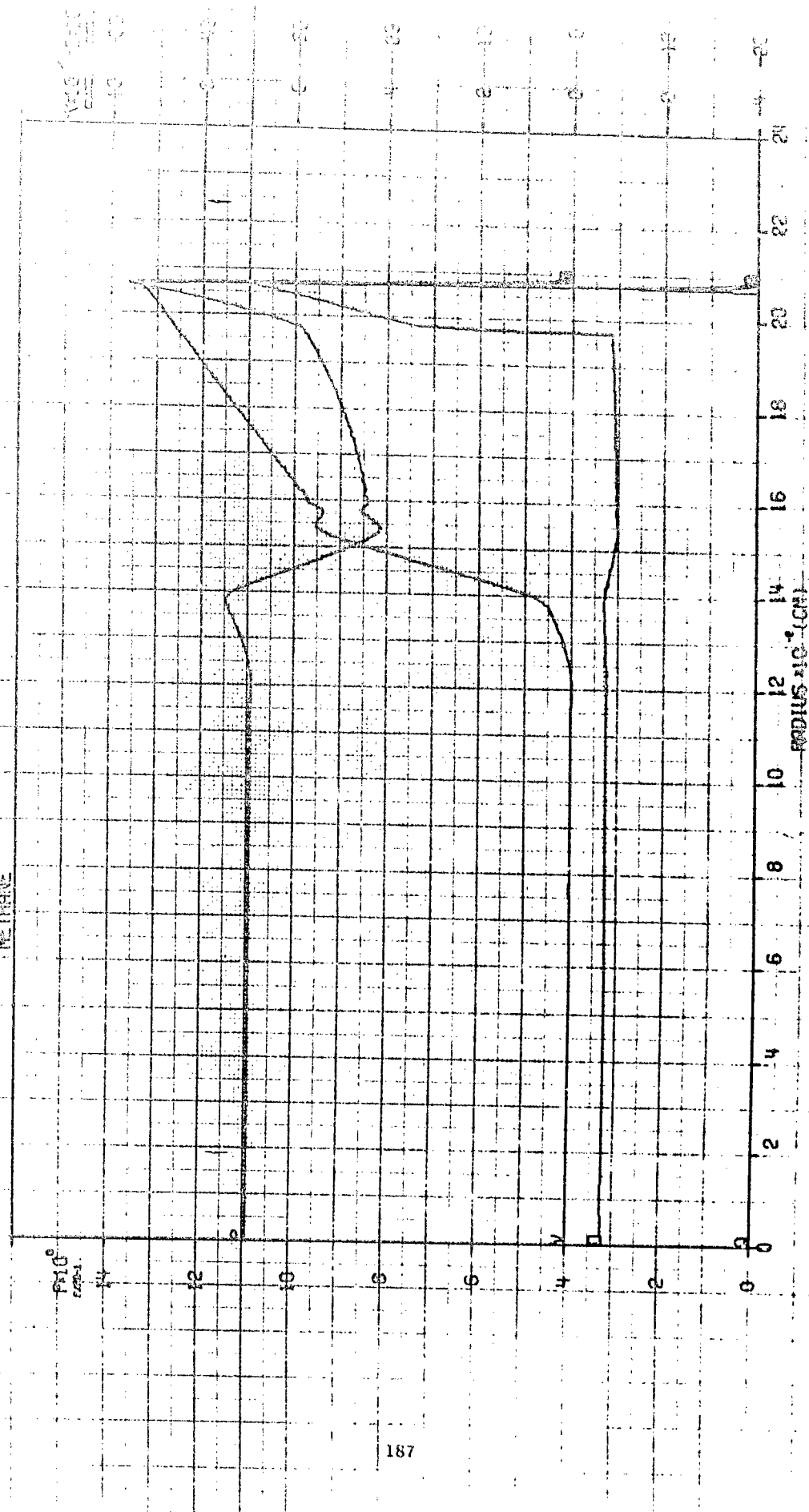
CYCLE	TIME	SEC.
4003	6:12:45	10



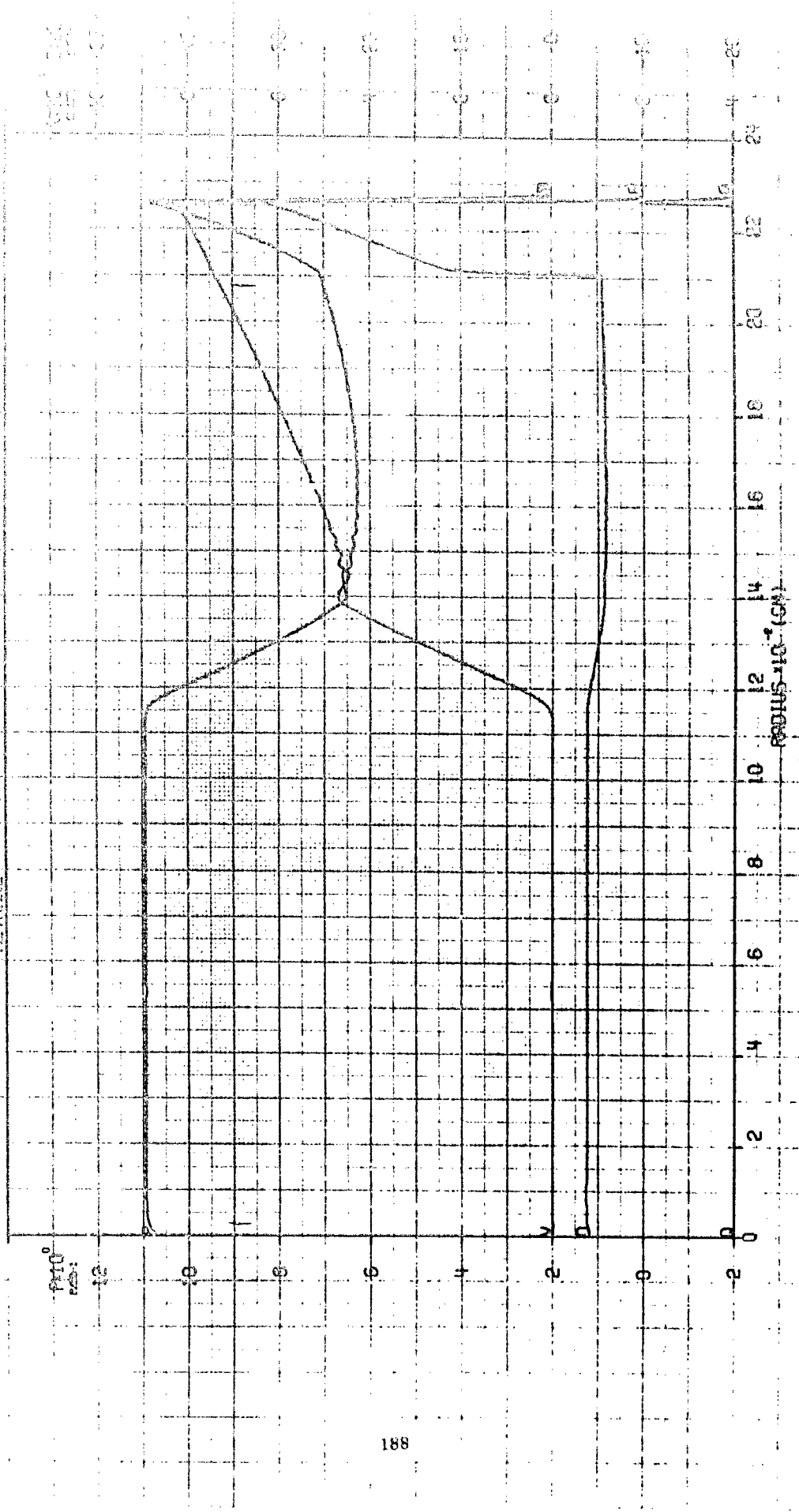
METHANE CYCLE 4828 TIME 7:00:00 10° 55C.



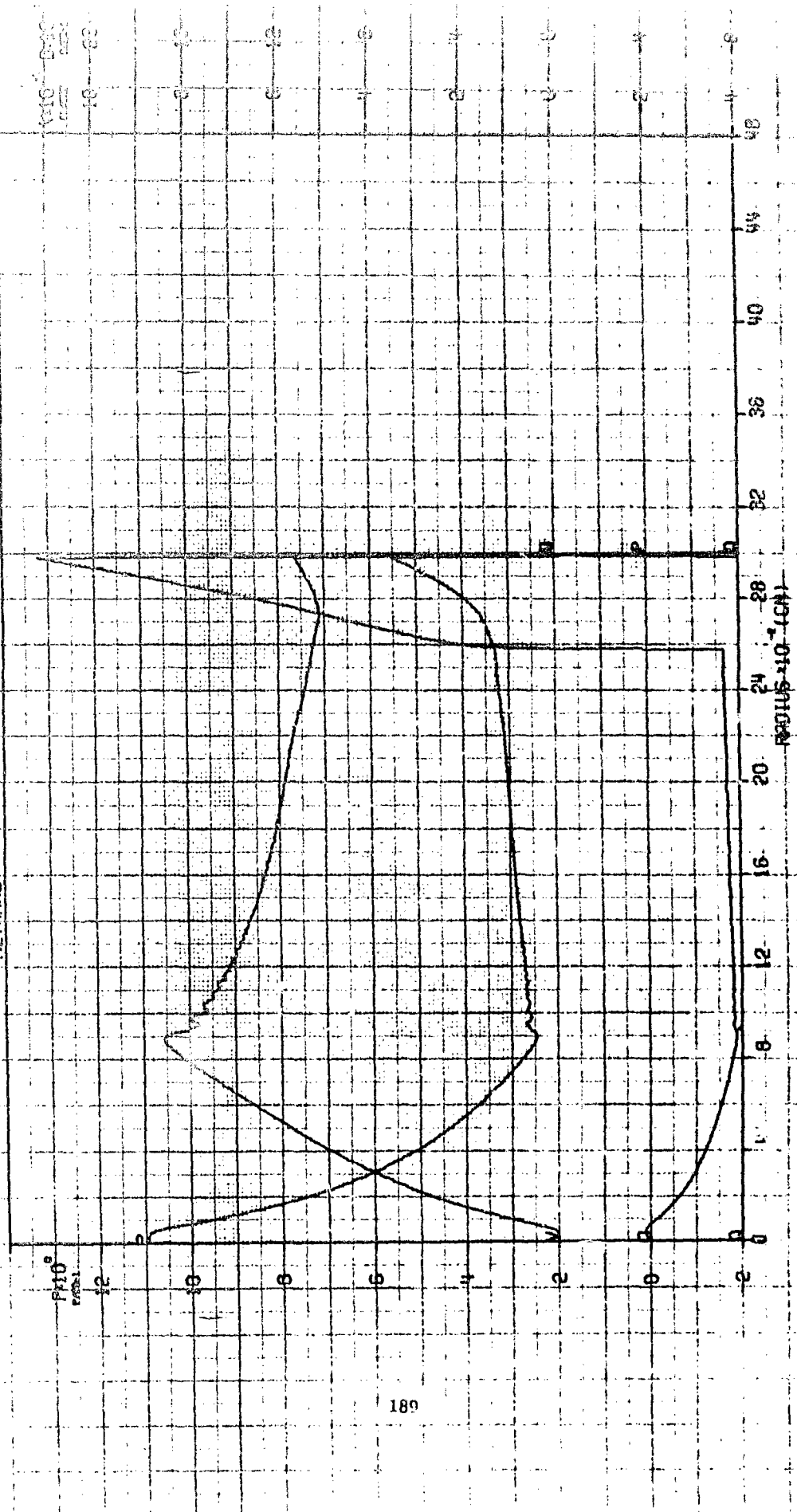
METHANE CYCLE 6000 TIME 9.08807 ± 10⁻³ SEC.



NETHANE CYCLE 7000 TIME 1.07800 $\times 10^{-3}$ SEC.

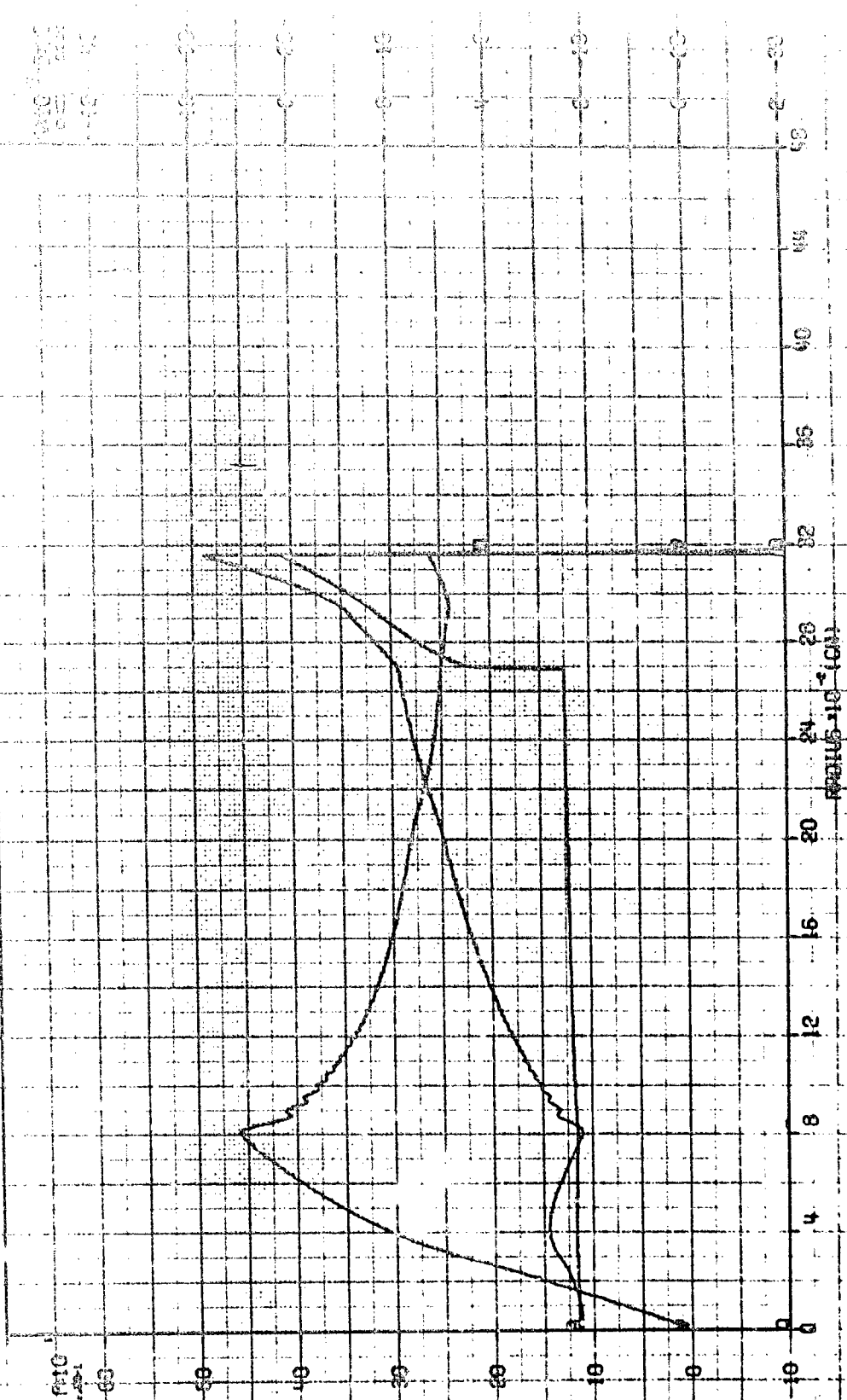


METHANE CYCLE 11000 TIME 1.82153 $\times 10^{-4}$ SEC.

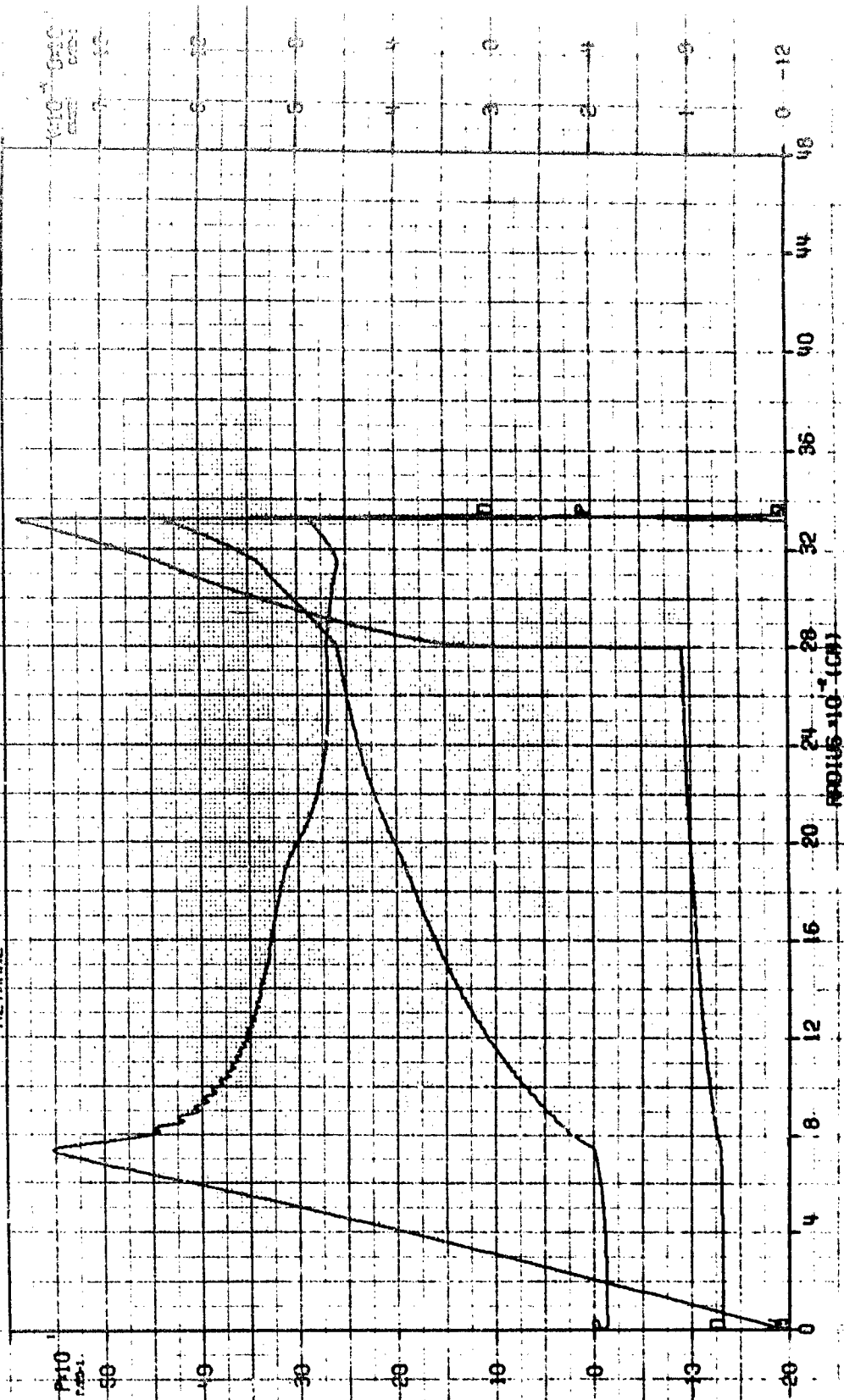


CYCLE 12000 TIME 2.00451 $\times 10^{-4}$ SEC.

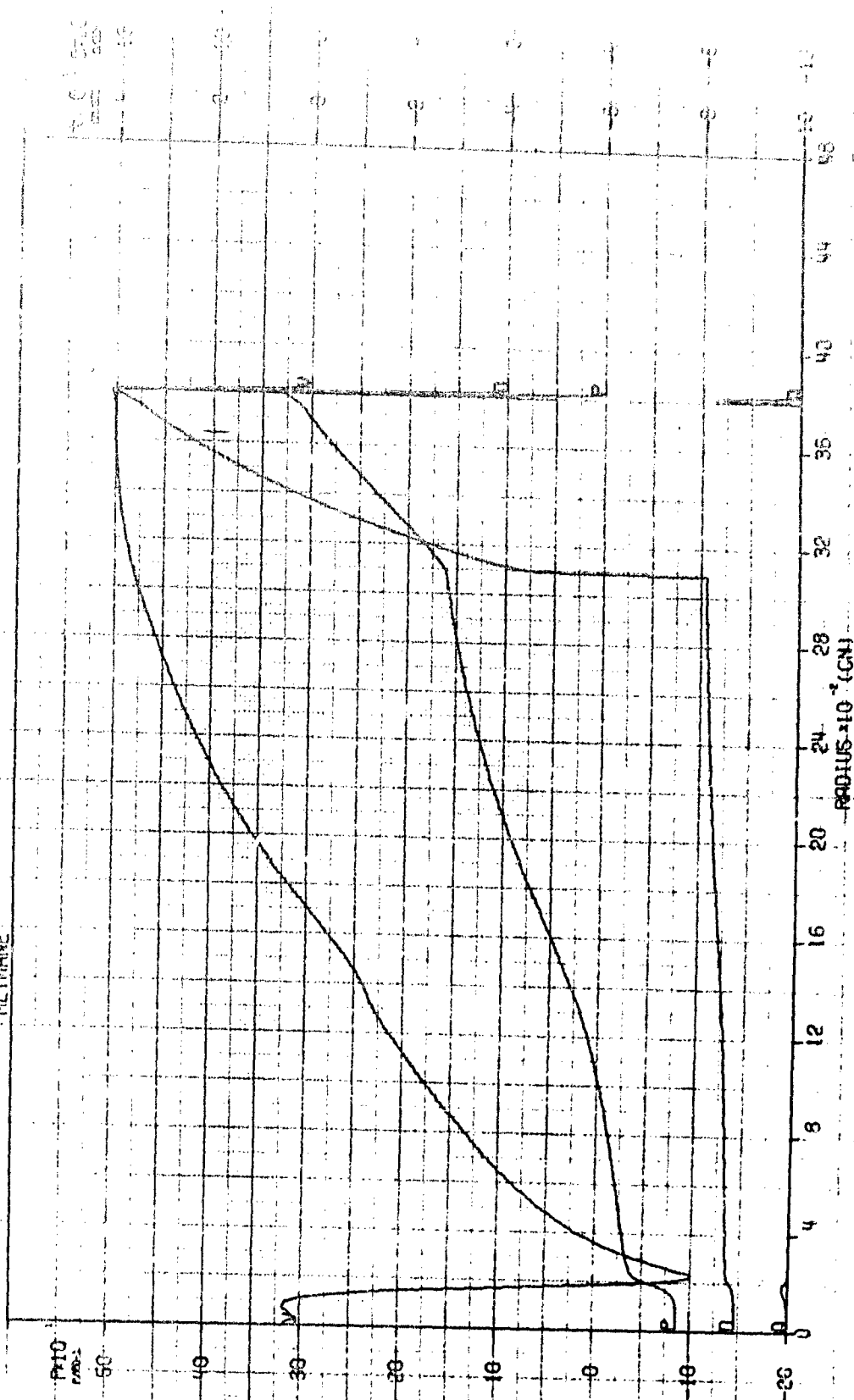
MEASURE



METHANE CYCLE 13000 TIME 2.30150 $\times 10^{-3}$ SEC.



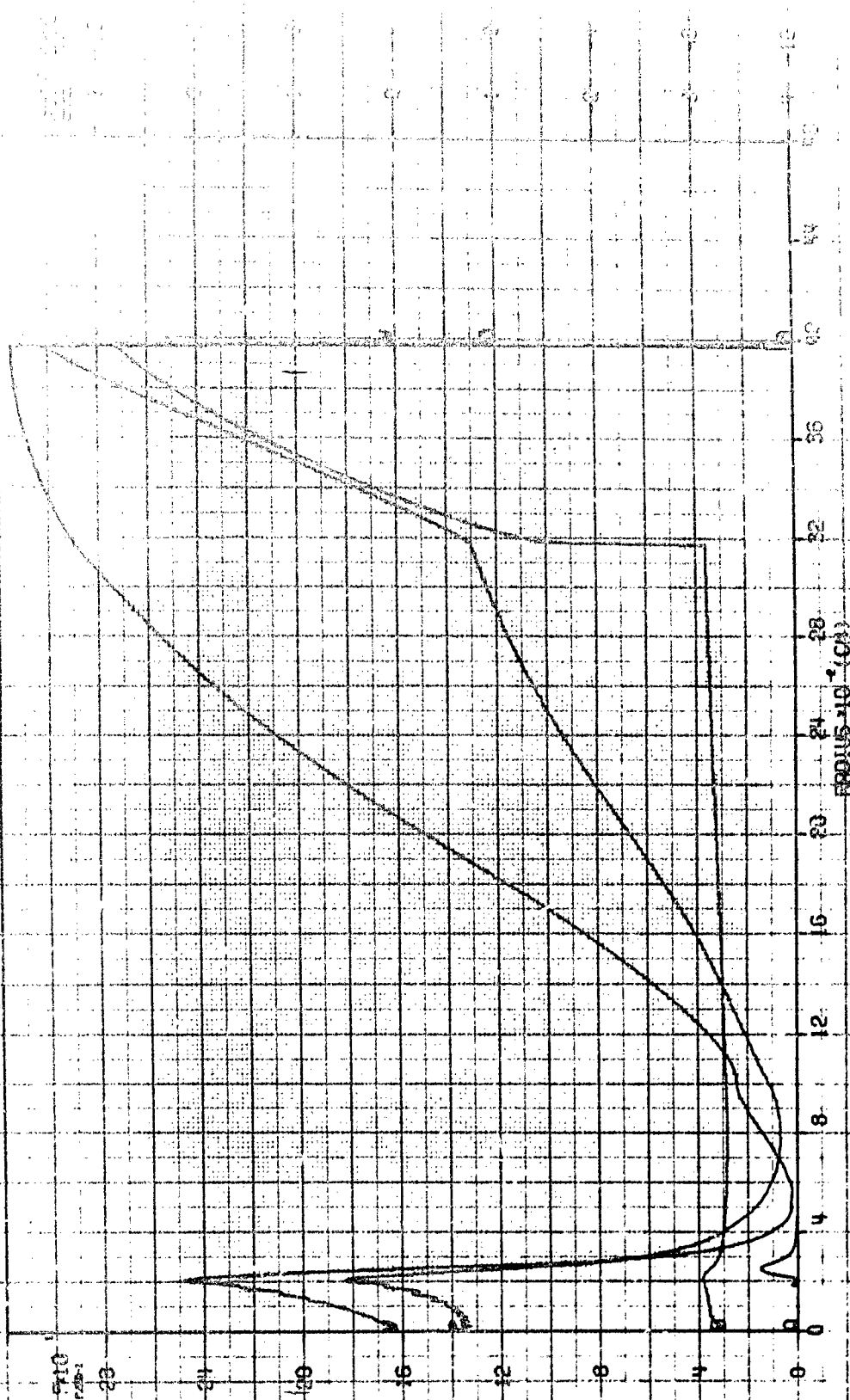
METHANE CYCLE 16213 TIME: 3.0000 $\times 10^{-5}$ SEC.



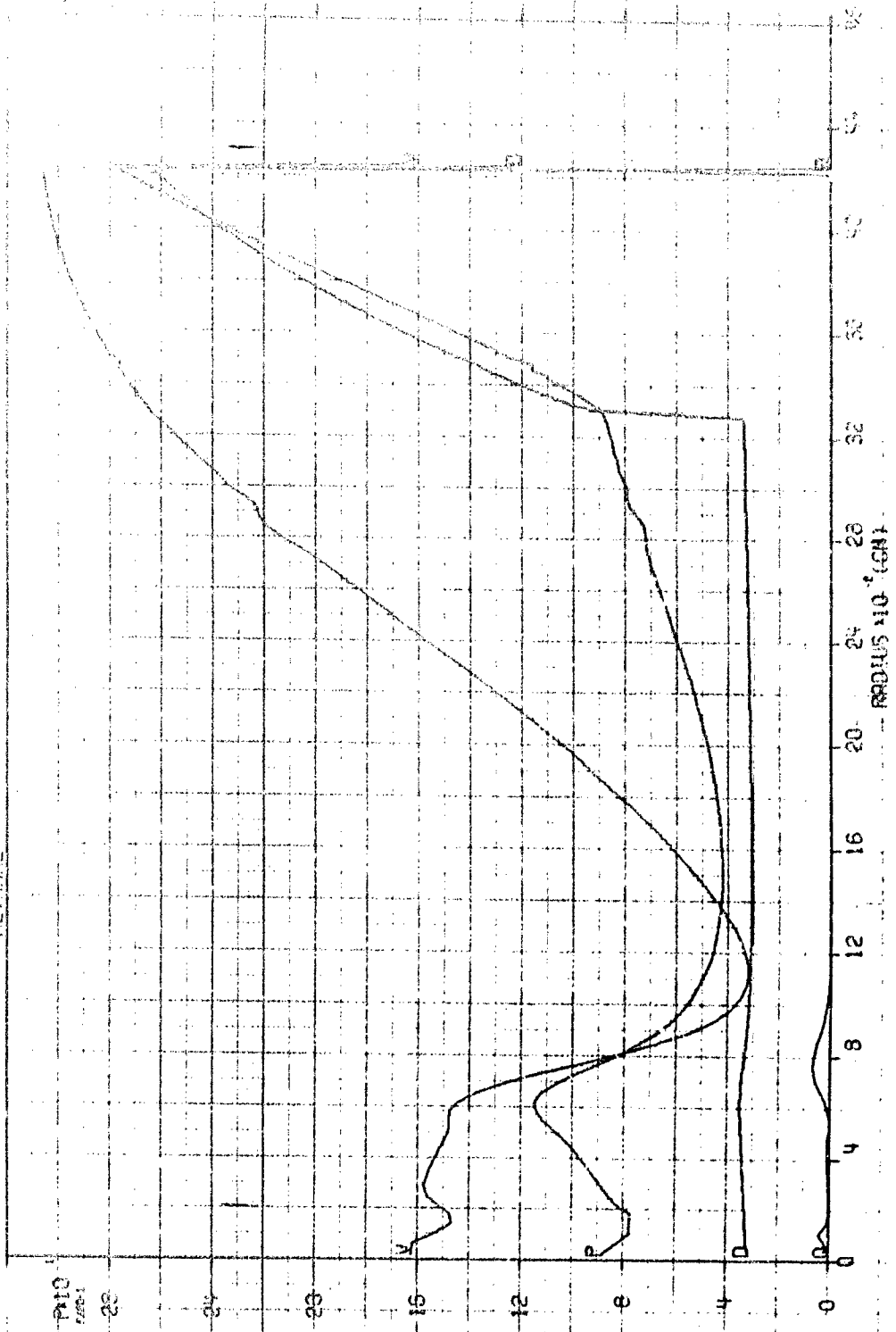
CYCLE 17937

WAVE 2:250312

WAVE 050



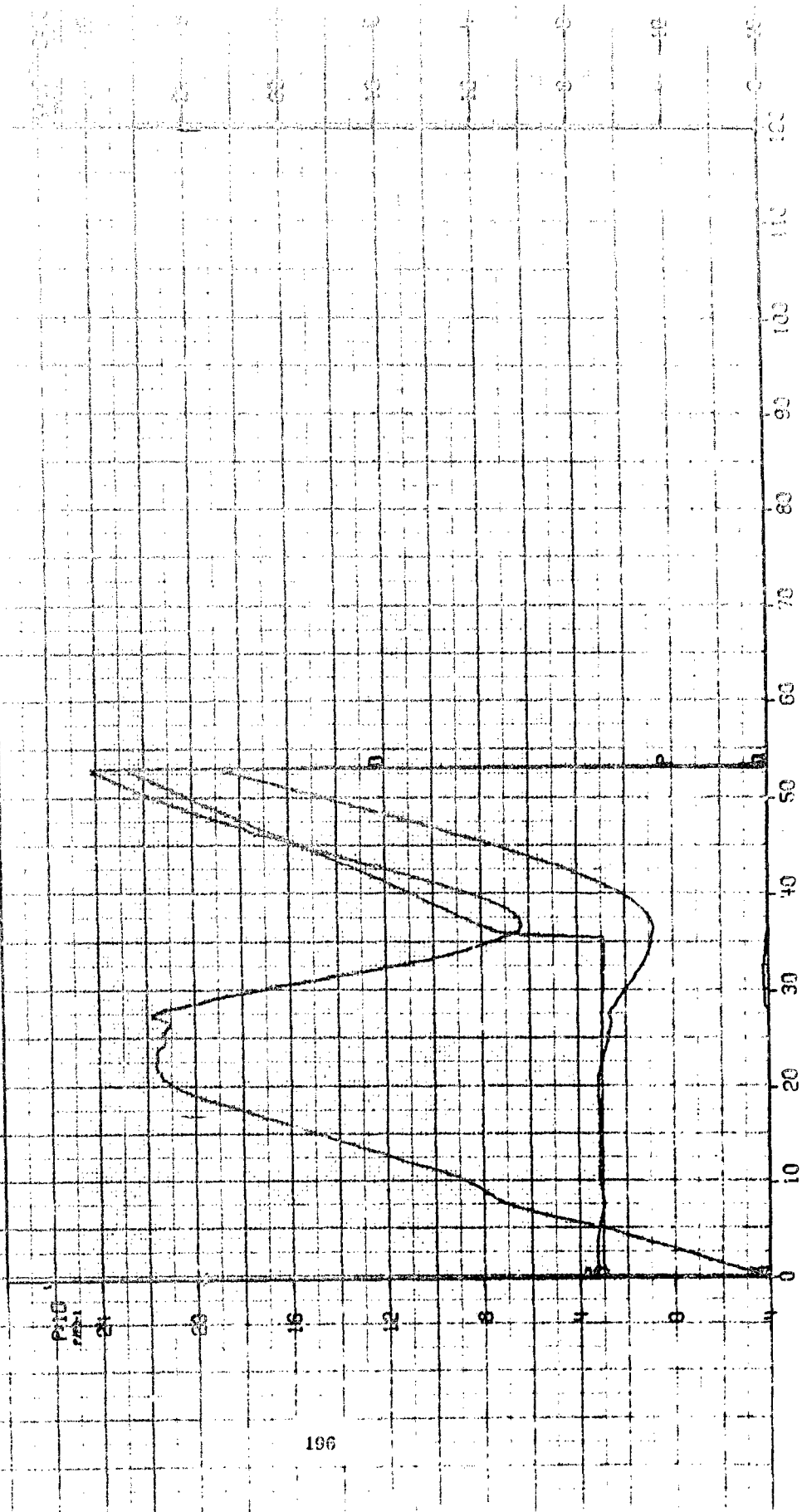
METHANE CYCLE (SSWS) TIME 0.00000 0.00000



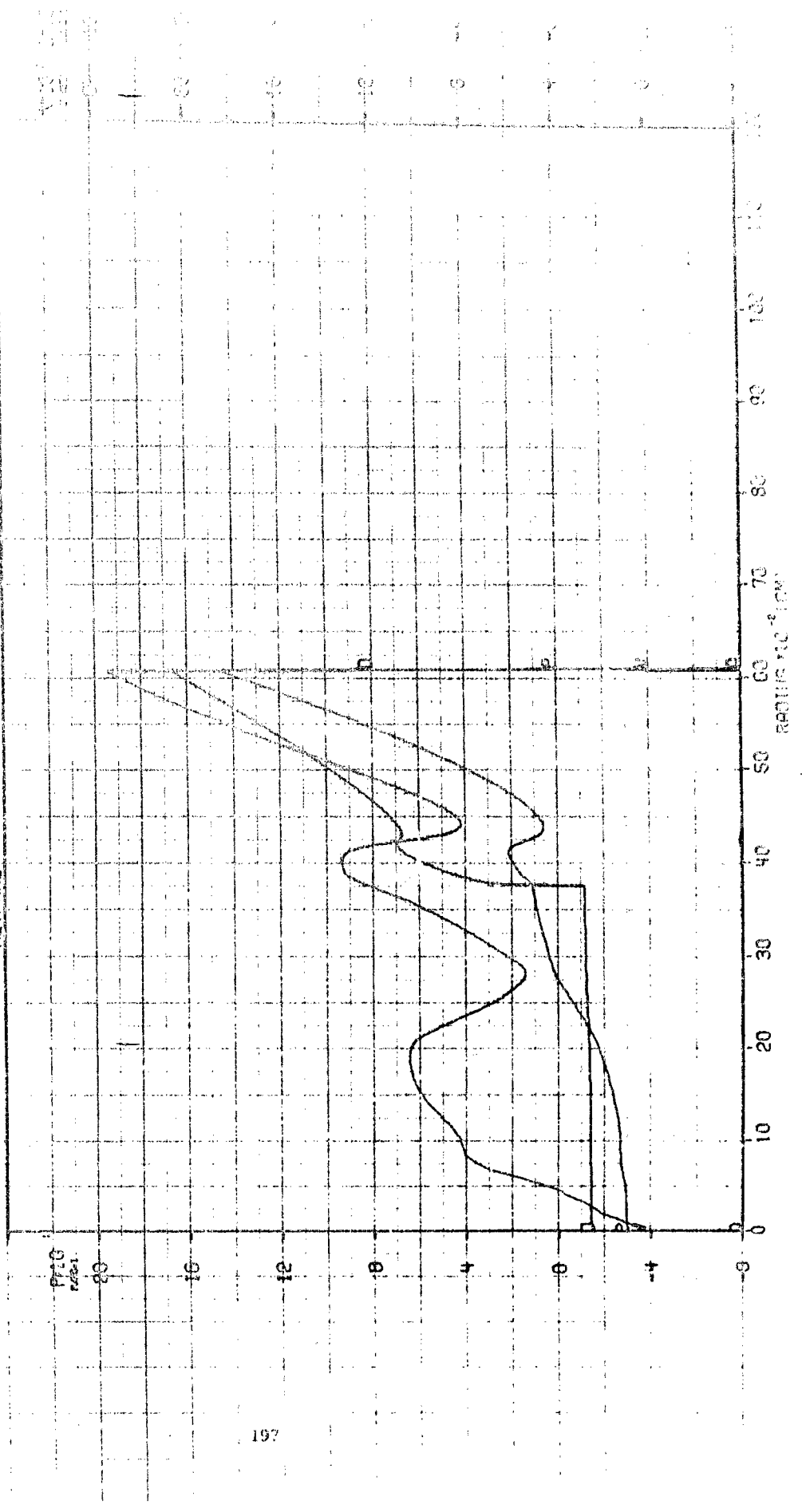
TIME 5.5222 10 SEC

CYCLE 21102

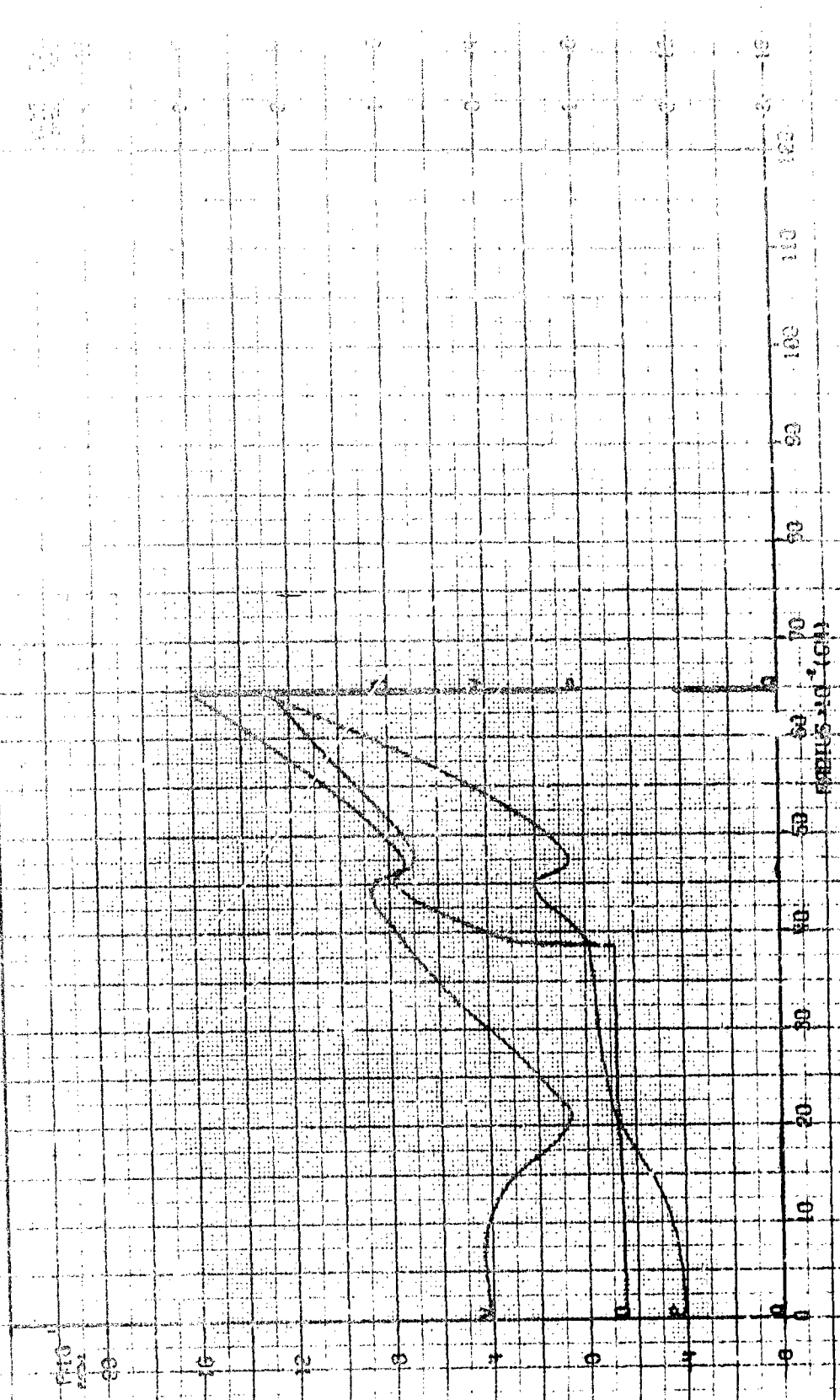
NETWORK



CYCLE 83390 TIME 7130.954 110.000
 METHANE

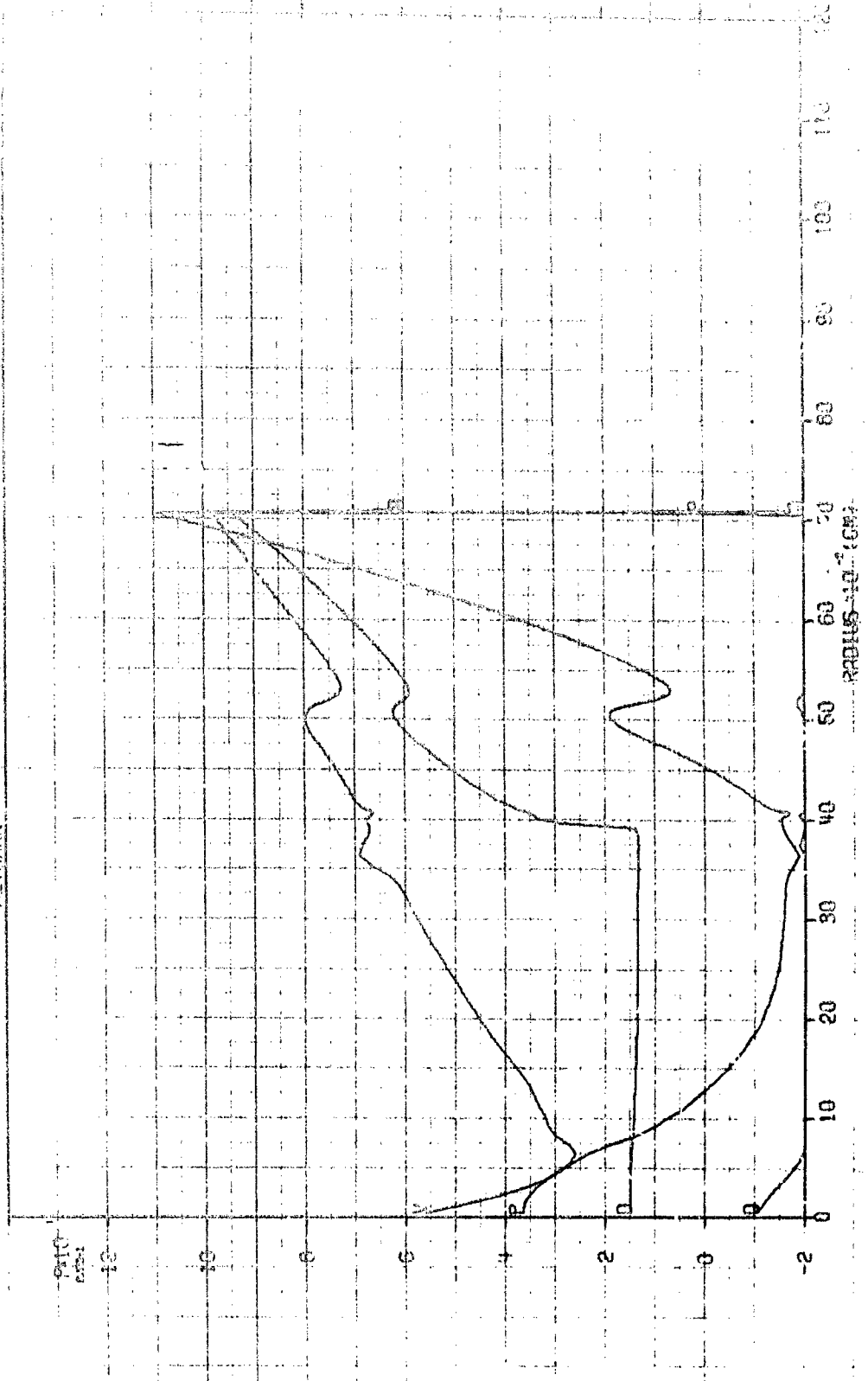


CYCLE 24025
 METRO
 FILE # 75332 10-10-70

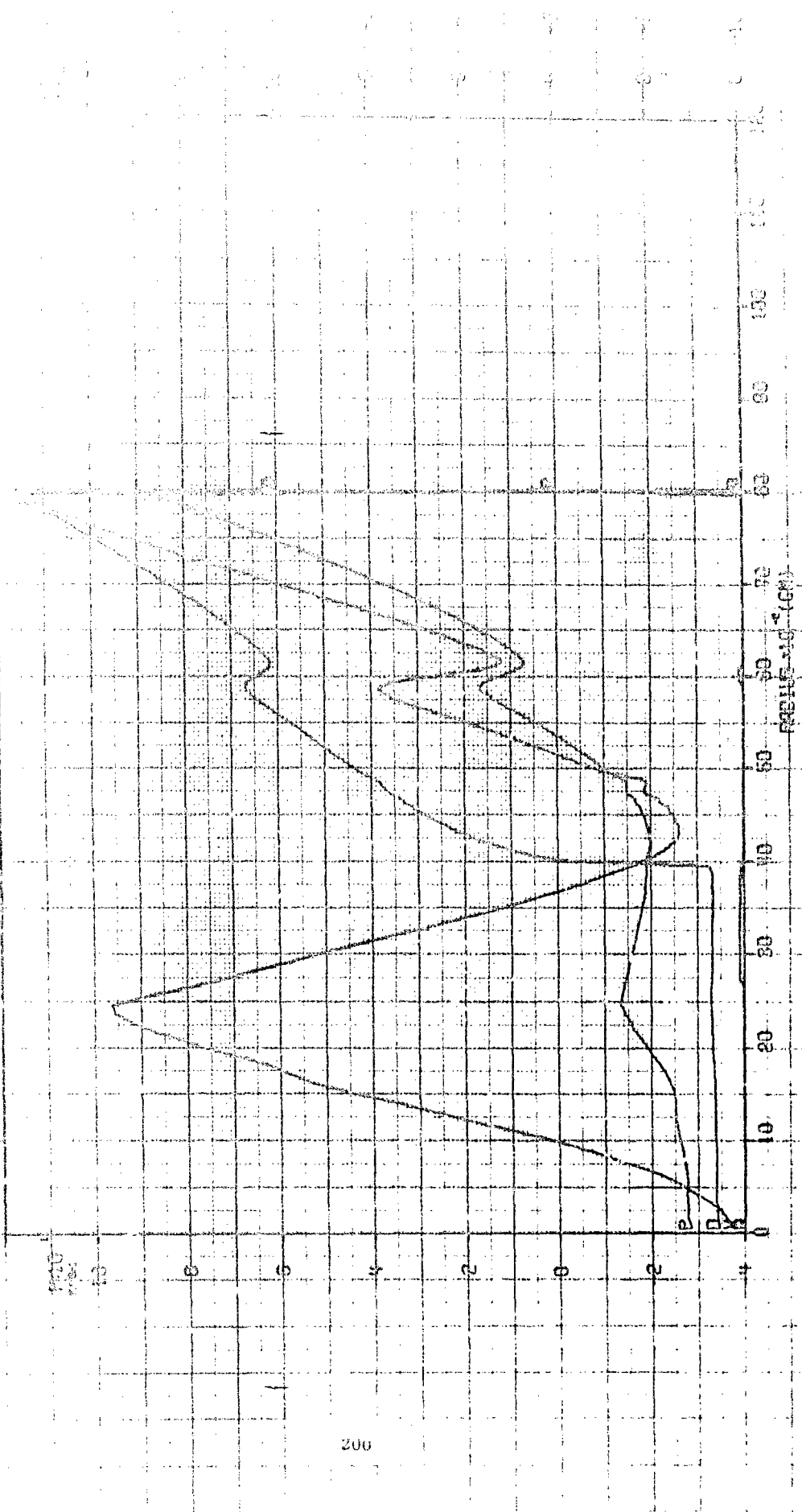


CYCLE 25528 TIME 9.03210 $\times 10^{-4}$ SEC

NETHER



REMARKS: CYCLE 27690 TIME 11:11:10 AM '68



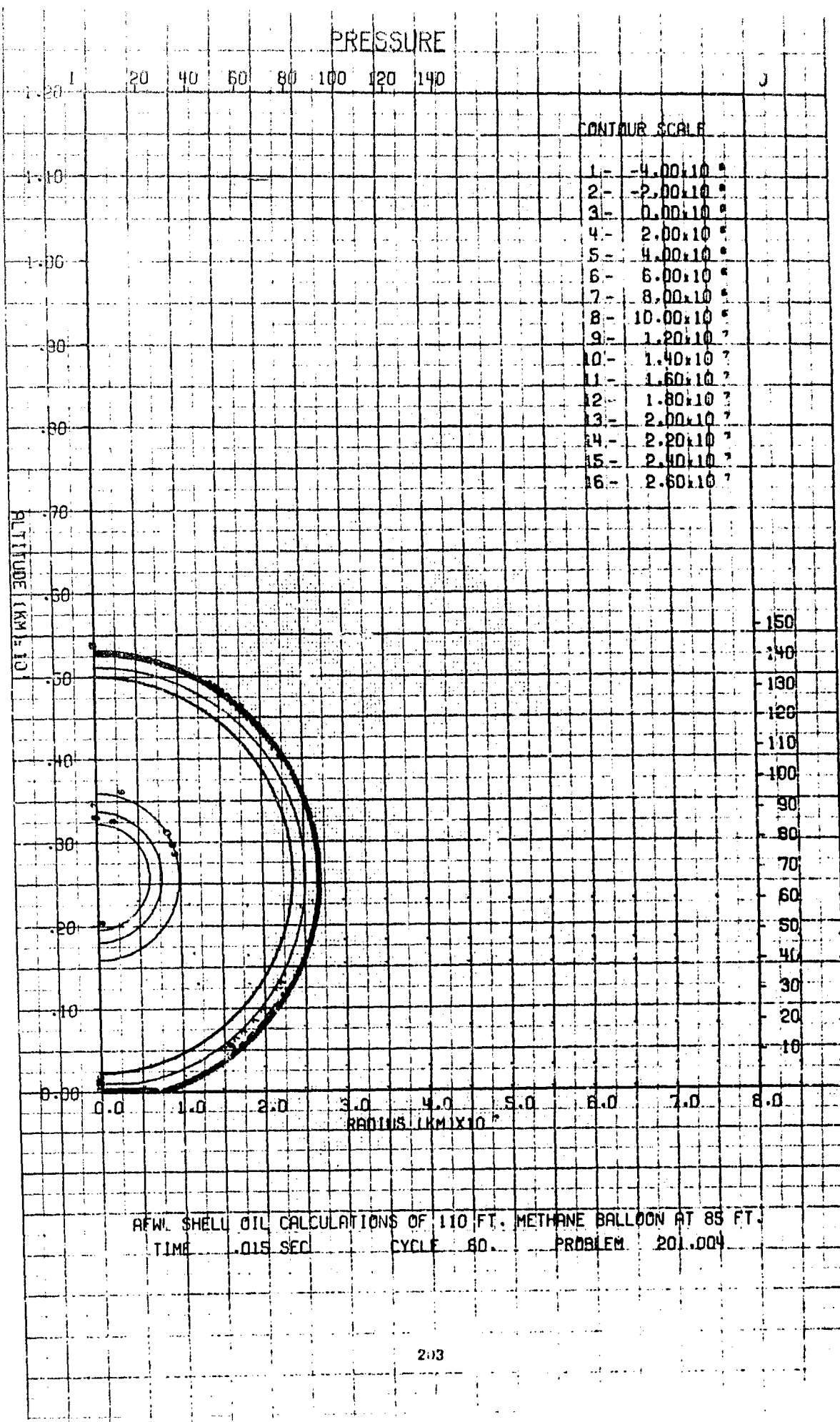
SHELL Contours and Velocity Vectors

This part contains pressure and density contours and velocity vector plots of the results of the SHELL-OIL calculation of the Methane detonation. There are plots for eight different times.

The first plot shows the reflection of the free-air shock at the ground. Subsequent plots show the formation and movement of the triple point and mach stem. The heavy black line on each plot shows the location of the massless trace particles which represent the methane-air interface at that time.

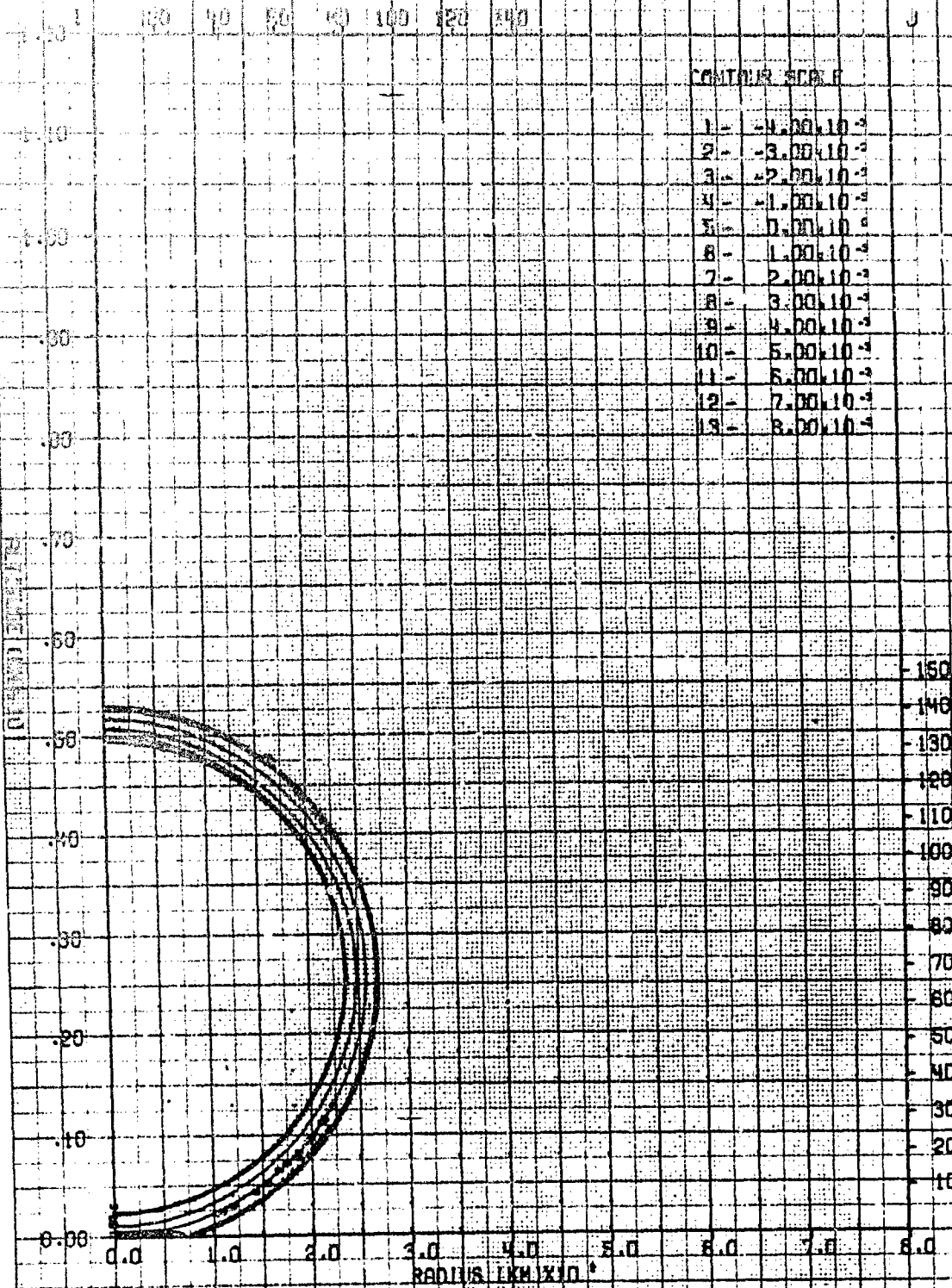
The numbers along the top of each plot represent the horizontal index of each cell of the mesh used in the calculation. The numbers along the right edge of the plot refer to vertical indices. The number associated with each contour line represents a value for that line appearing in the upper right-hand corner of each contour plot. The velocity vector scale is similarly given in the upper right-hand corner of each velocity vector plot.

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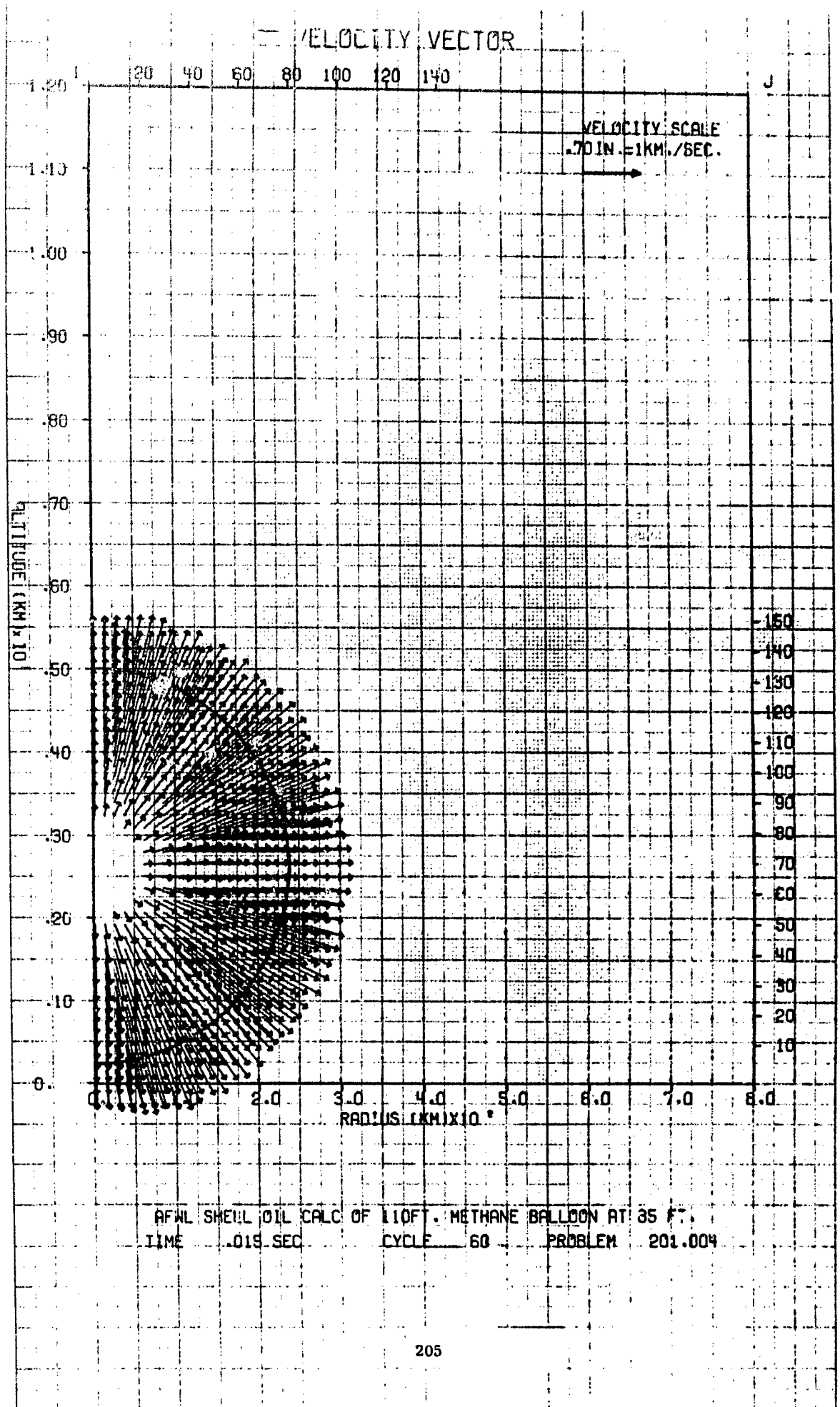


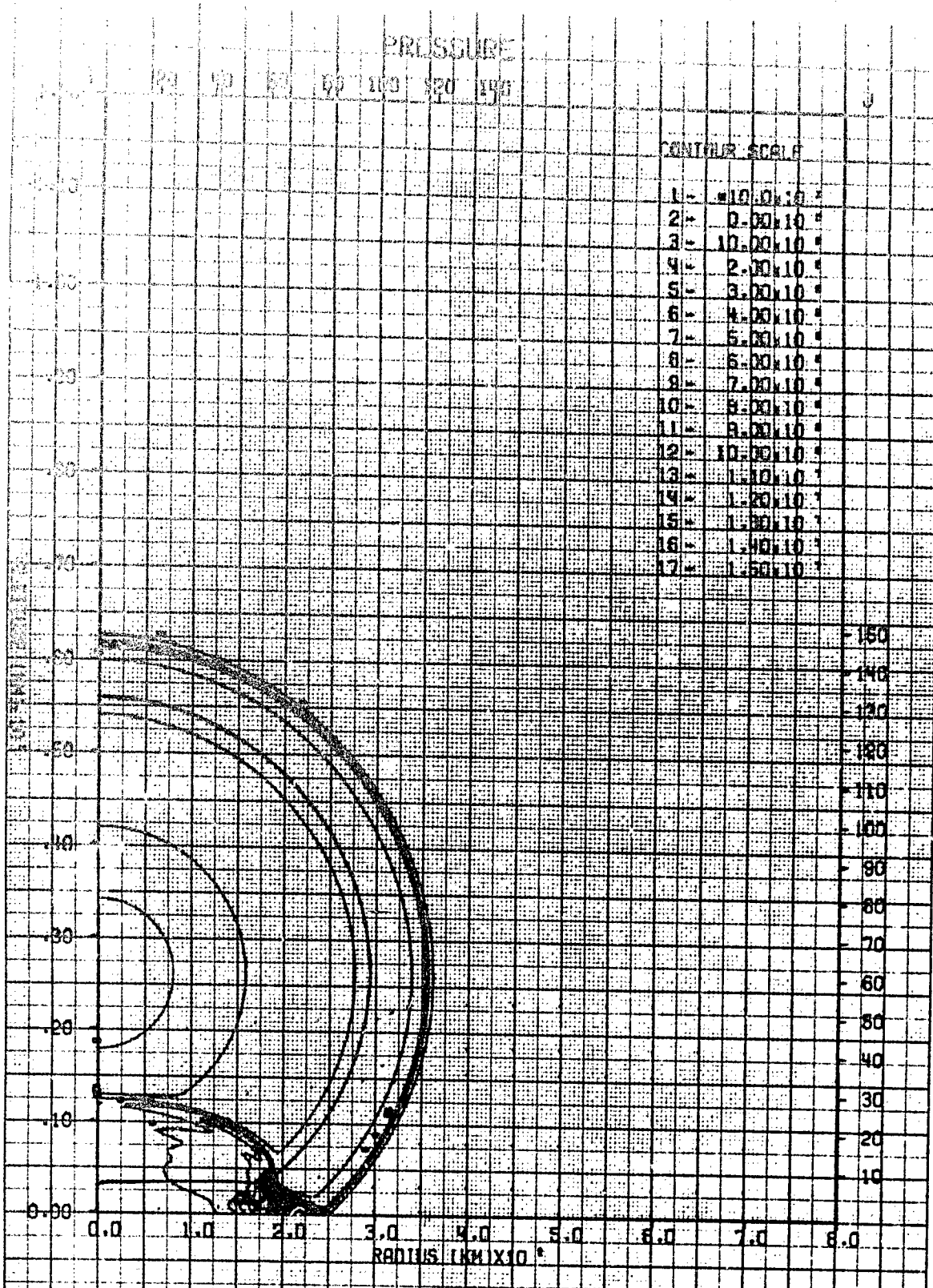
AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.
 TIME .015 SEC CYCLE 60. PROBLEM 201.004

DENSITY

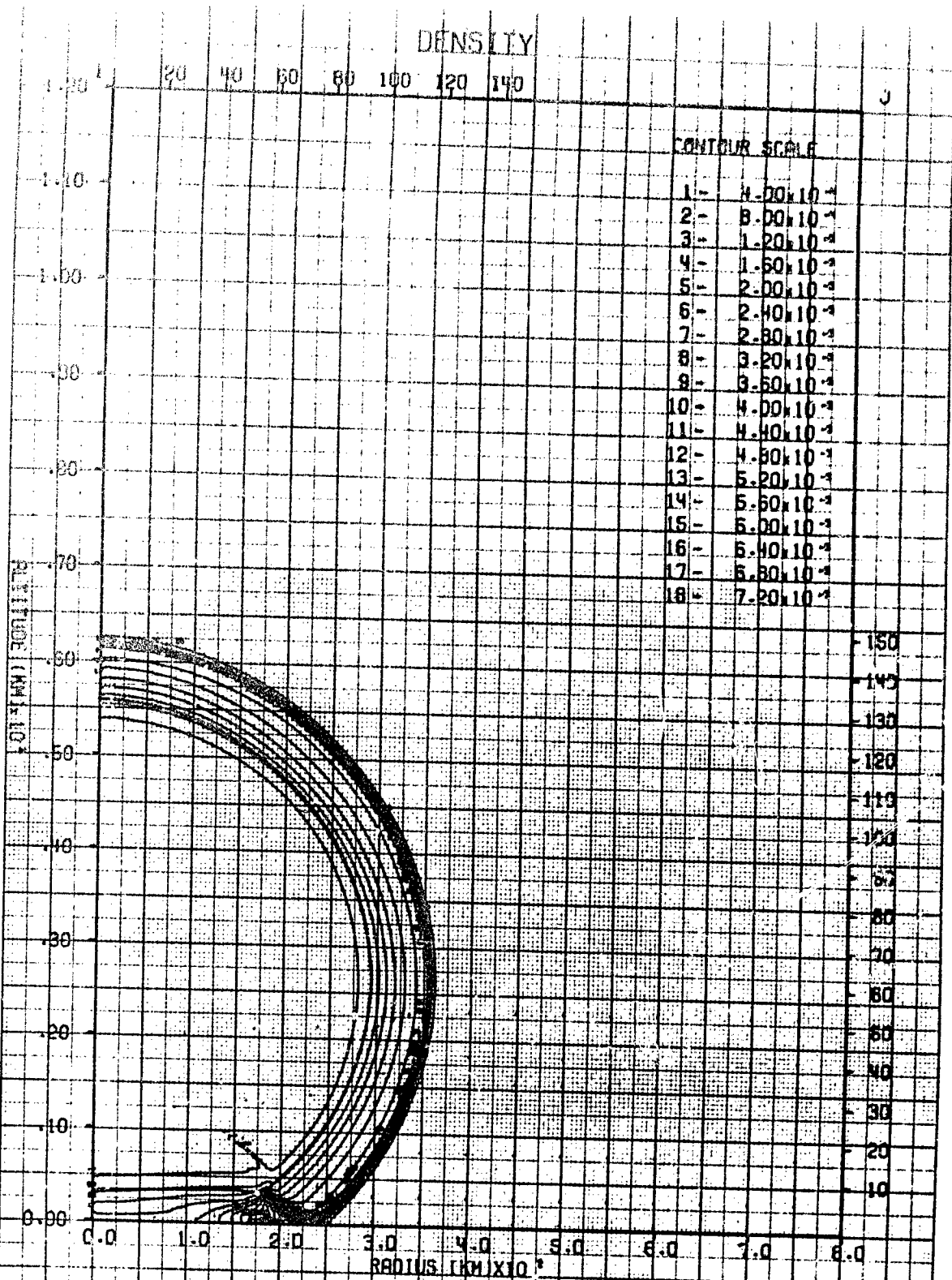


AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.
 TIME .015 SEC CYCLE 80. PROBLEM POL.004





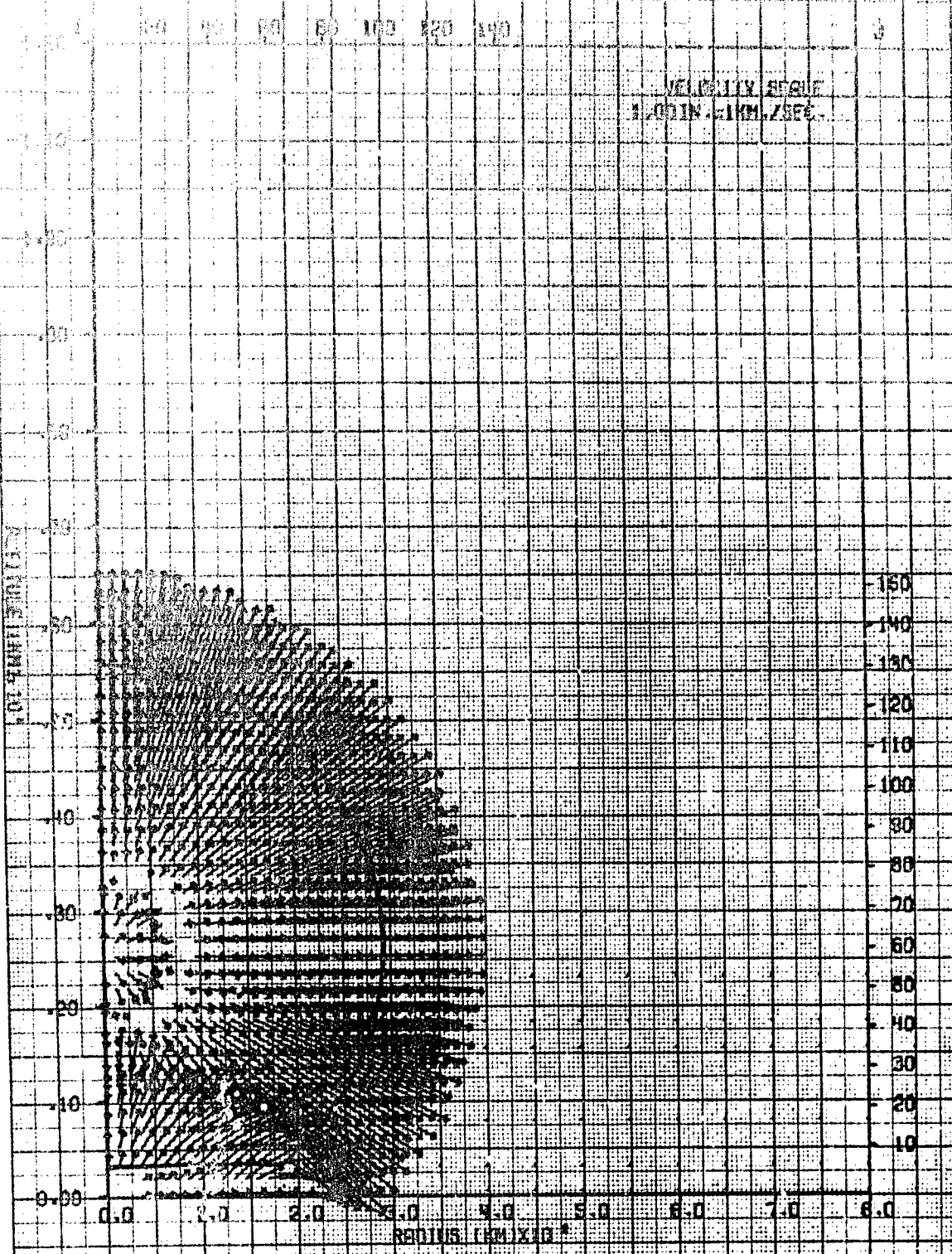
AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.
 TIME 026 SEC CYCLE 151 PROBLEM 201.004 9



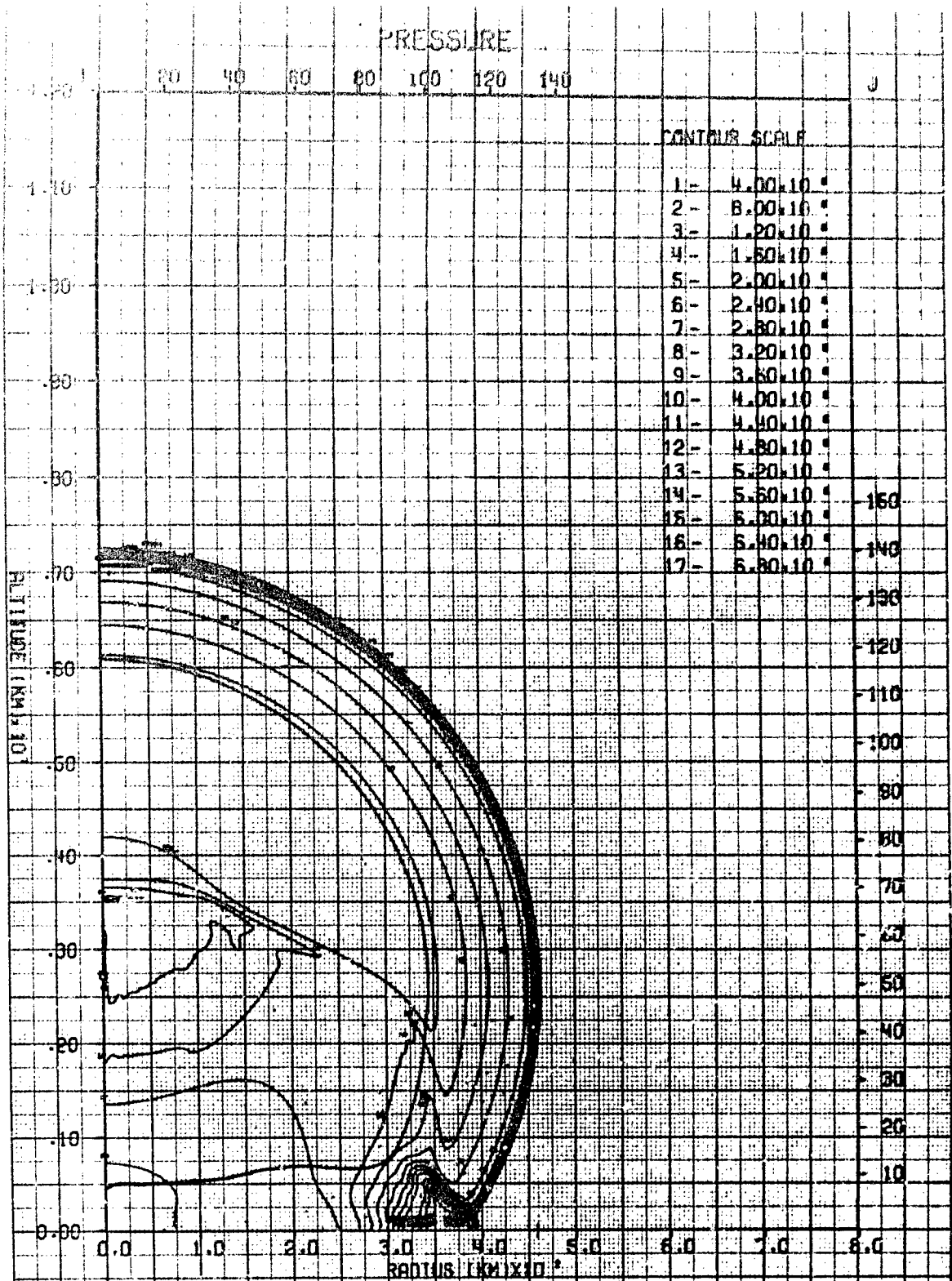
AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.

TIME .026 SEC CYCLE 151. PROBLEM 201.009 /%

VELOCITY VECTOR



AFHL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.
 TIME .026 SEC CYCLE 151 PROBLEM 201.004 //



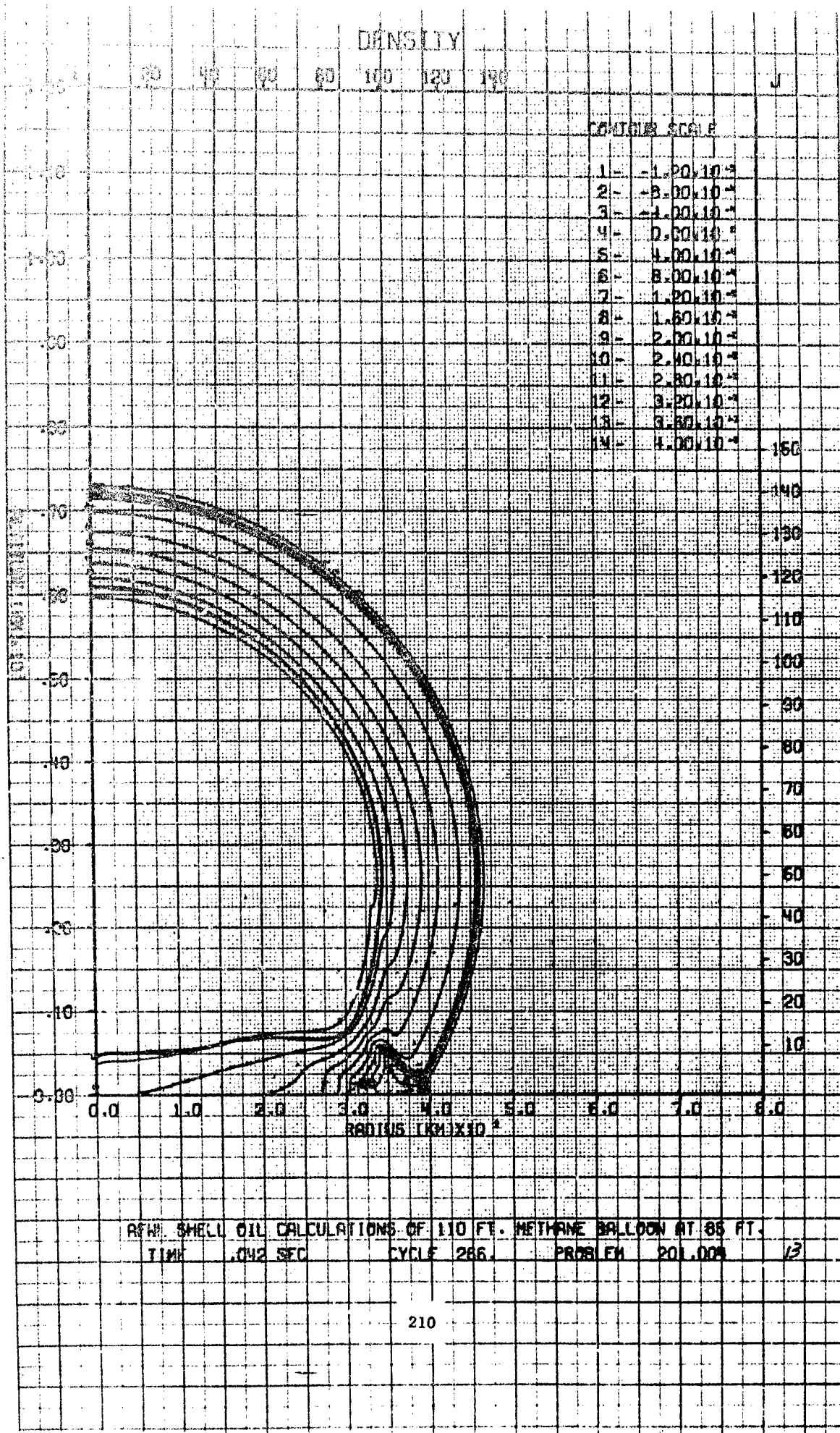
AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.

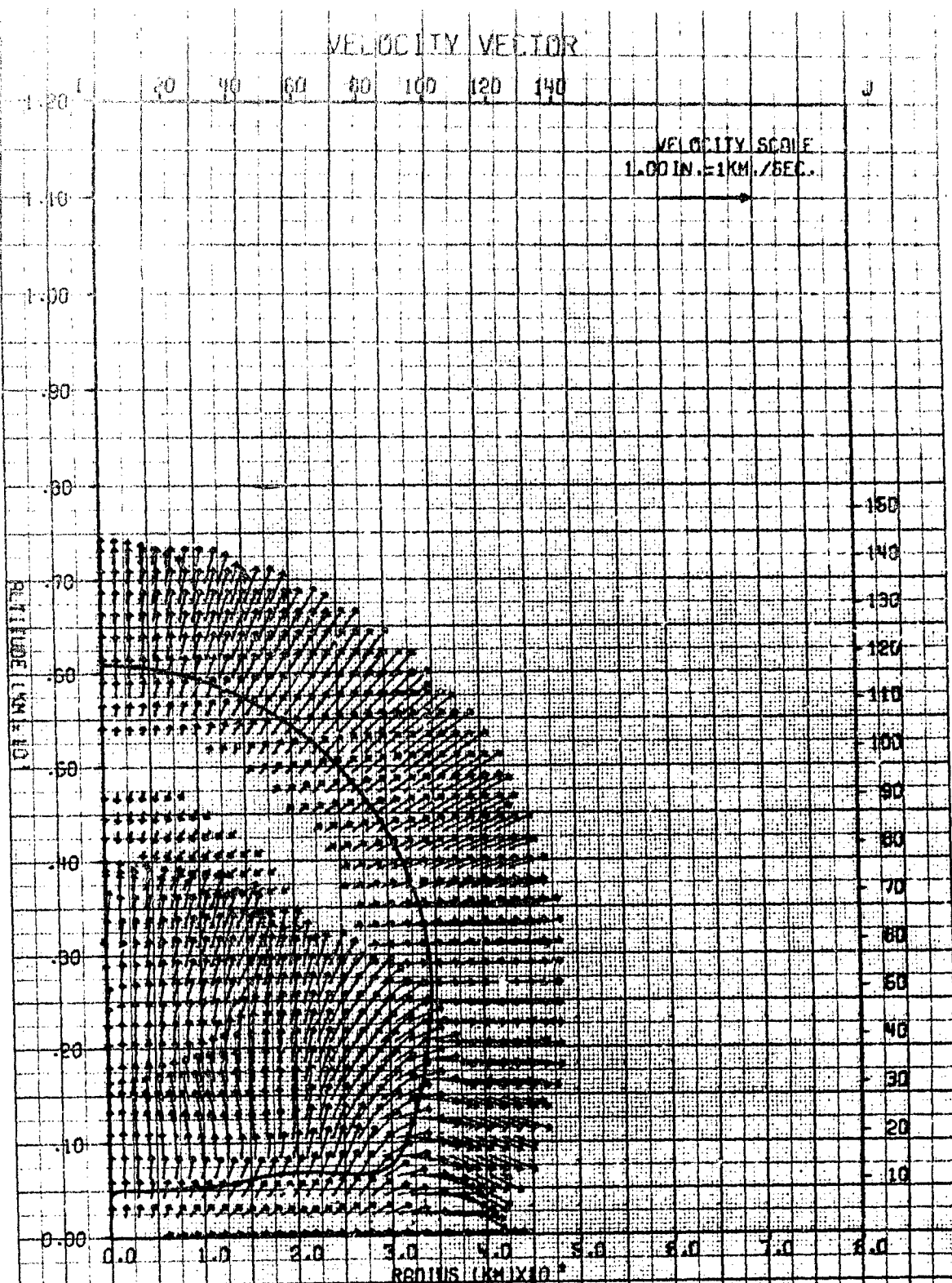
TIME 042 SEC

CYCLE 286

PROBLEM 201.004

1/2





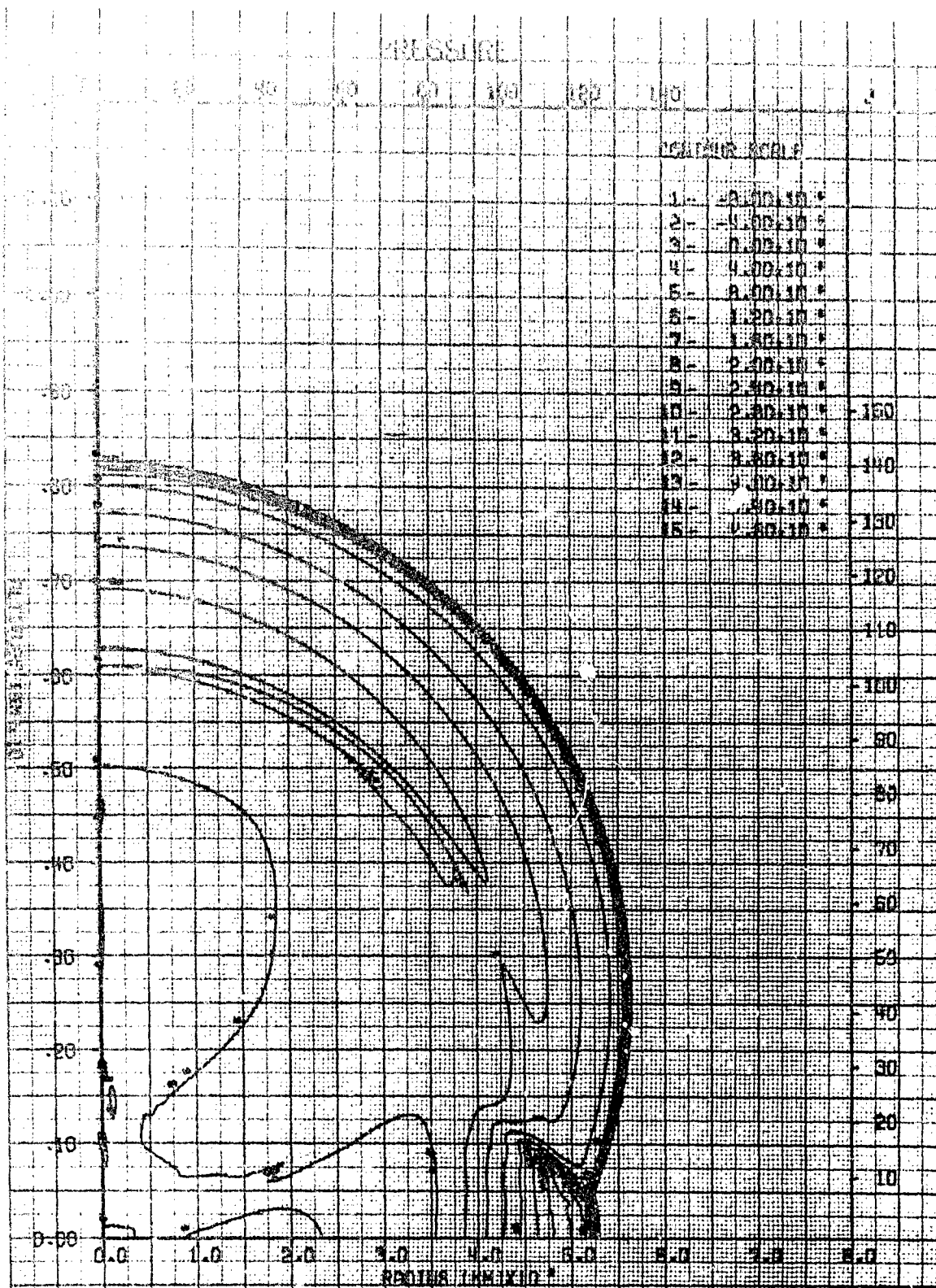
AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.

TIME .042 SEC

CYCLE 286.

PROBLEM 201.004

74



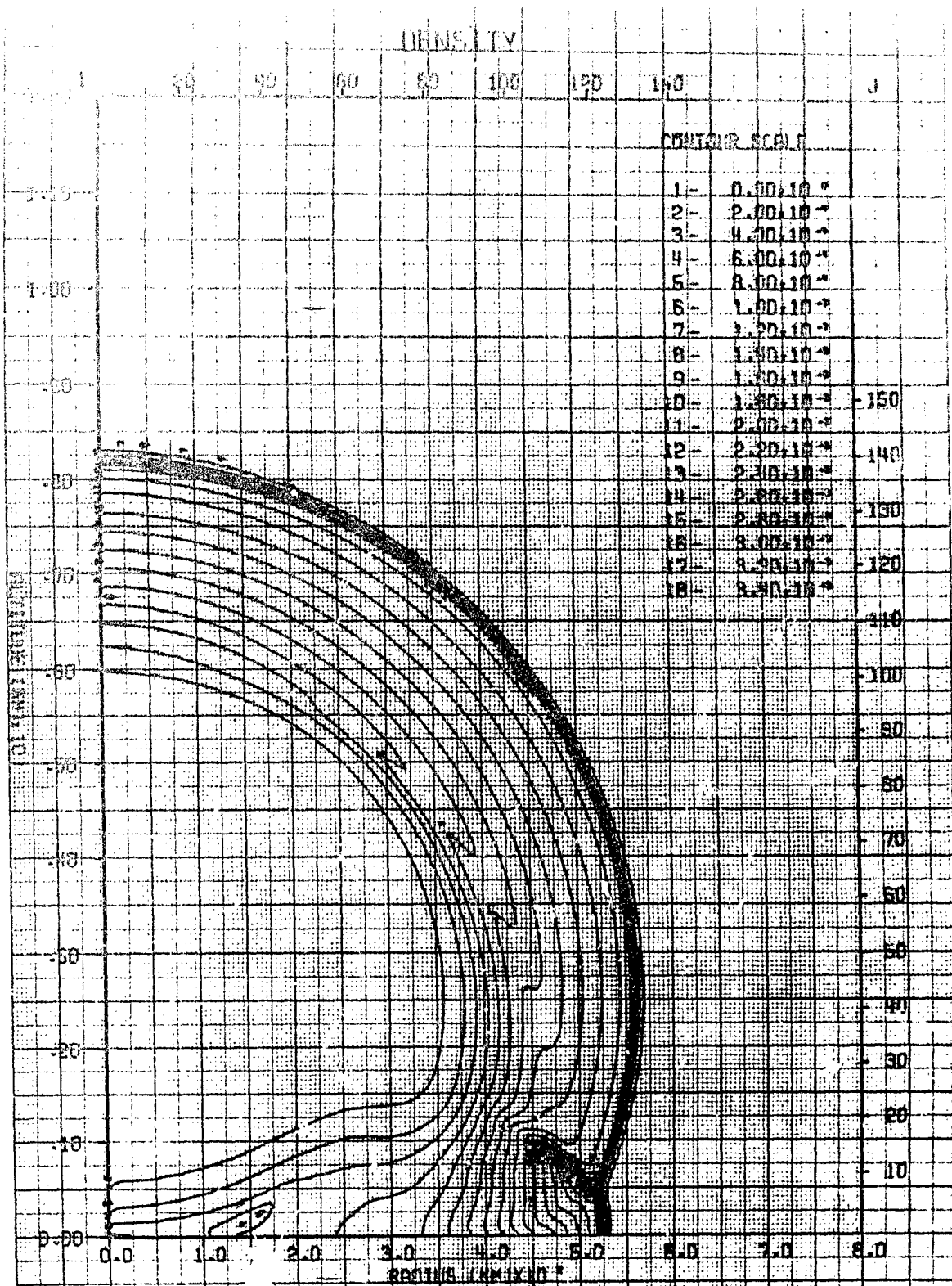
AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.

TIME .060 SEC

CYCLE 387

PROBLEM 20.000

15



AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE GALLON AT 88 FT.

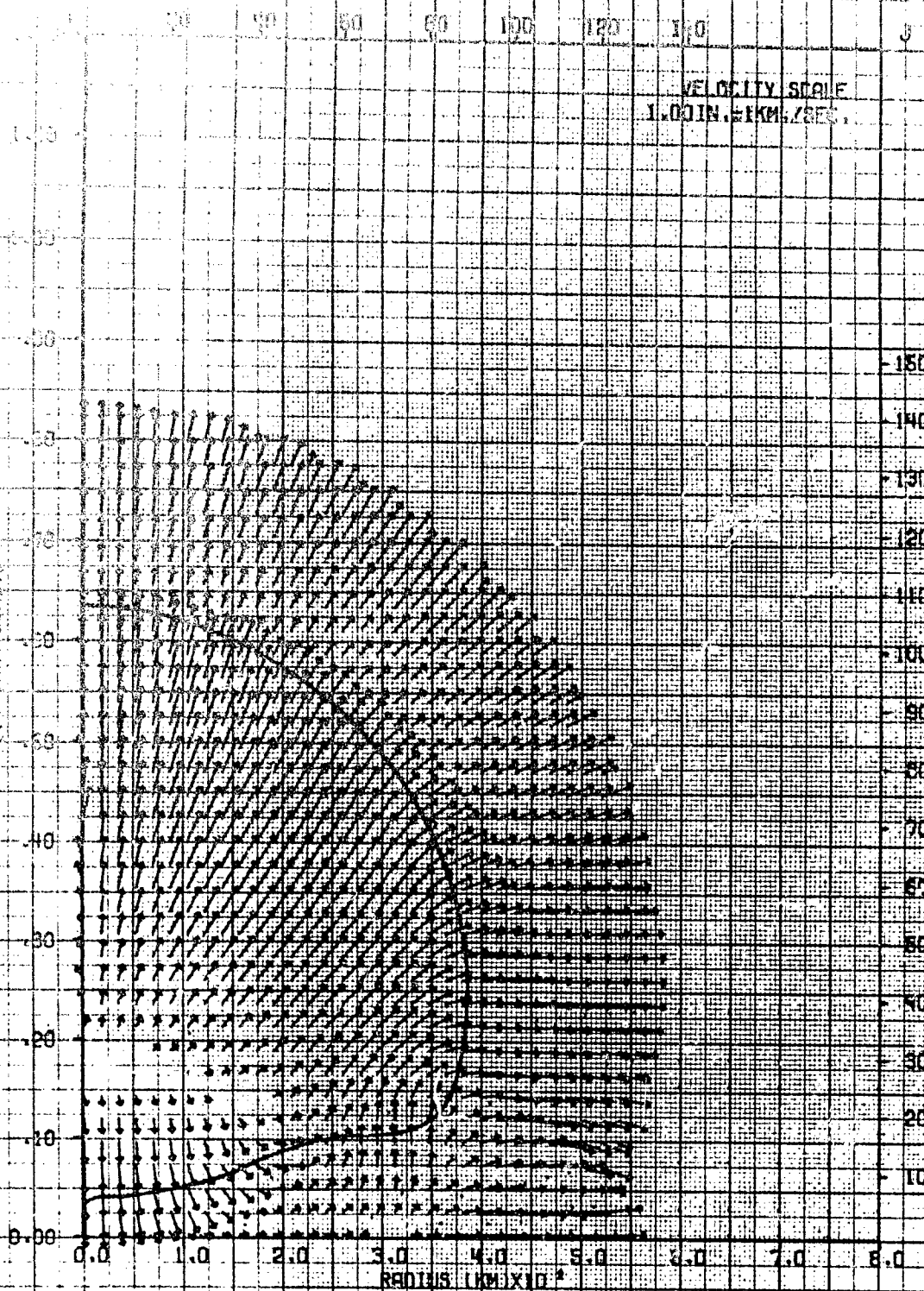
TIME .060 SEC

CYCLE 367

PROBLEM 201.004

16

VELOCITY VECTOR



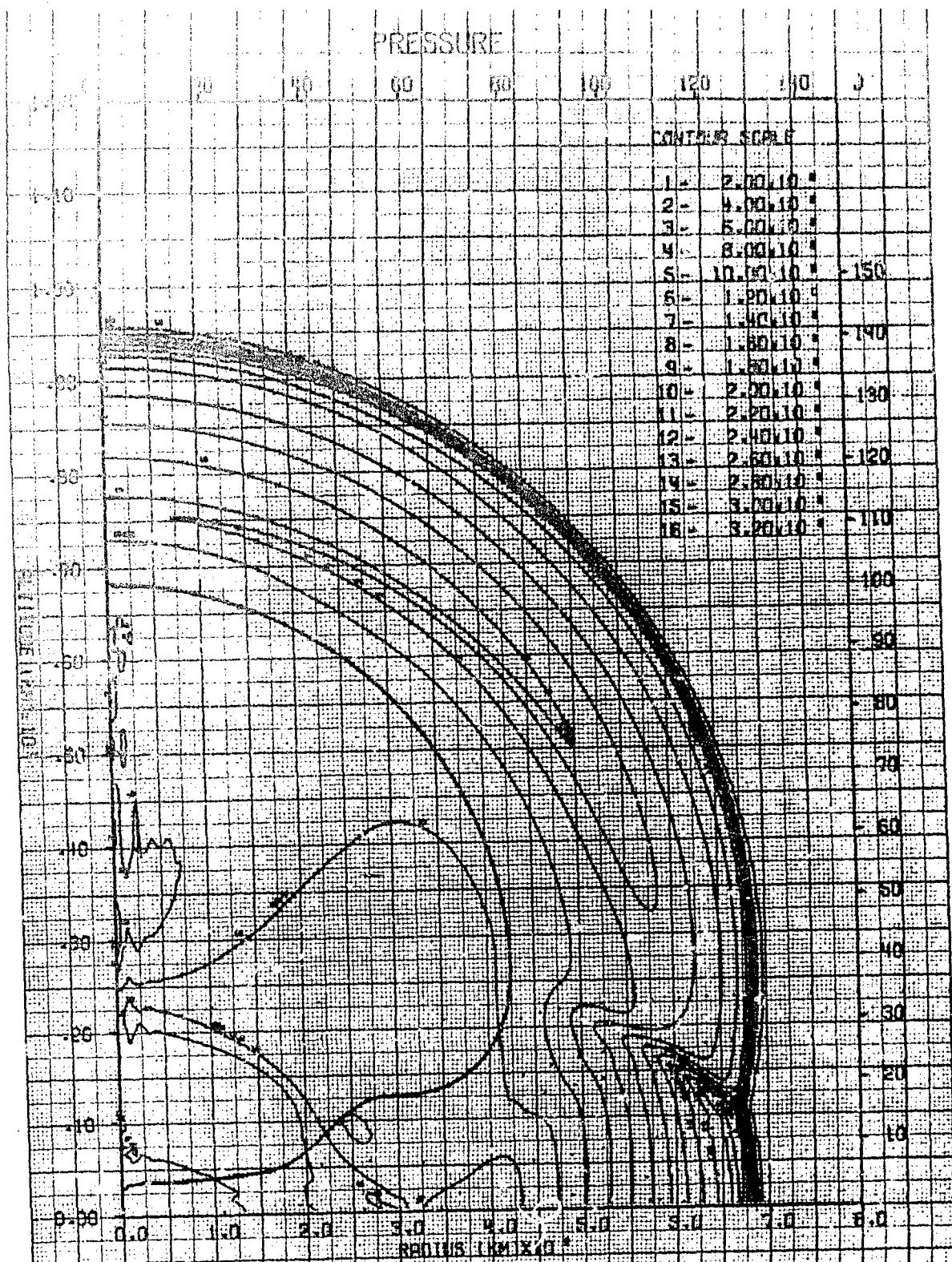
AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.

TIME .060 SEC

CYCLE 367

PROBLEM 201.009

/2



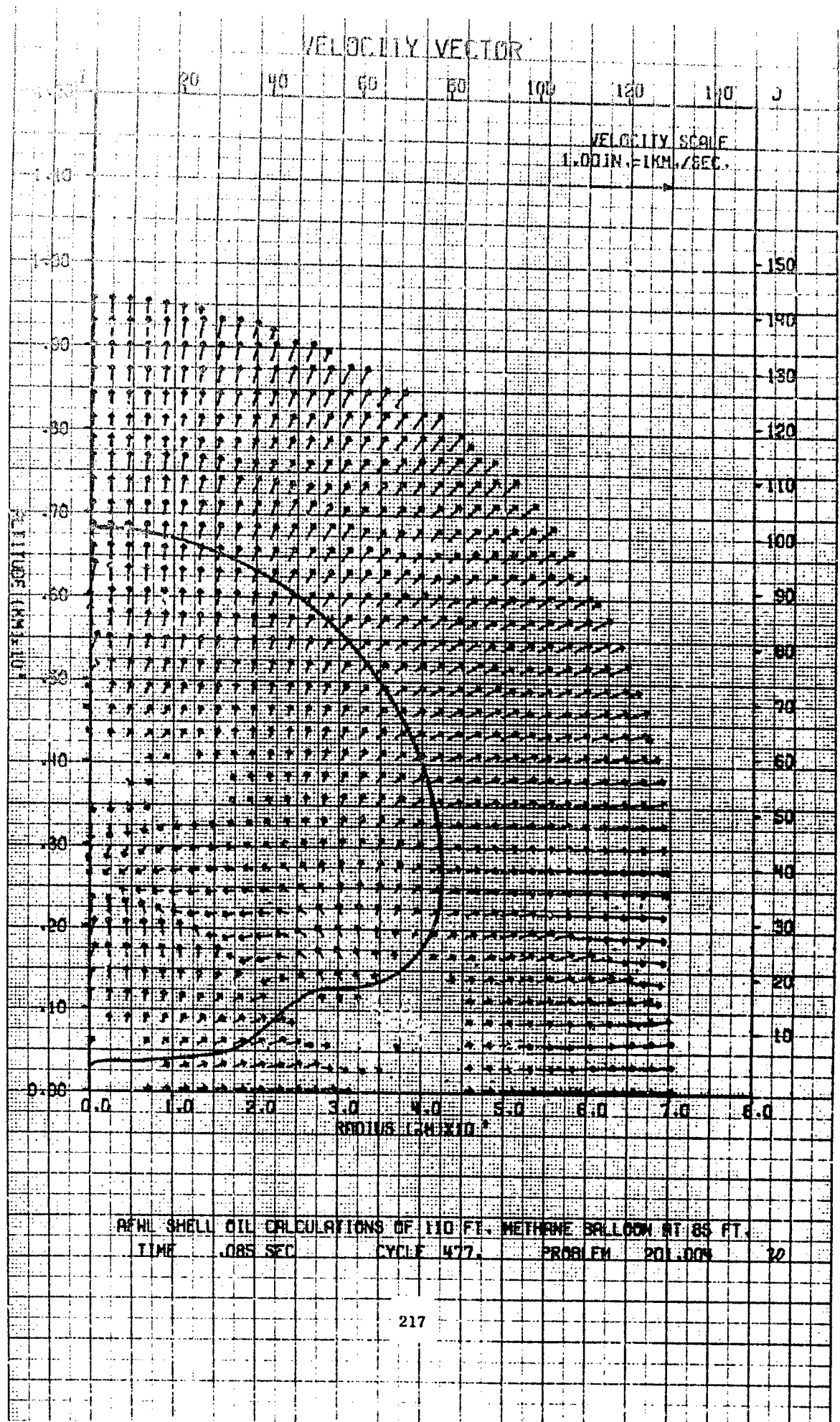
AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.

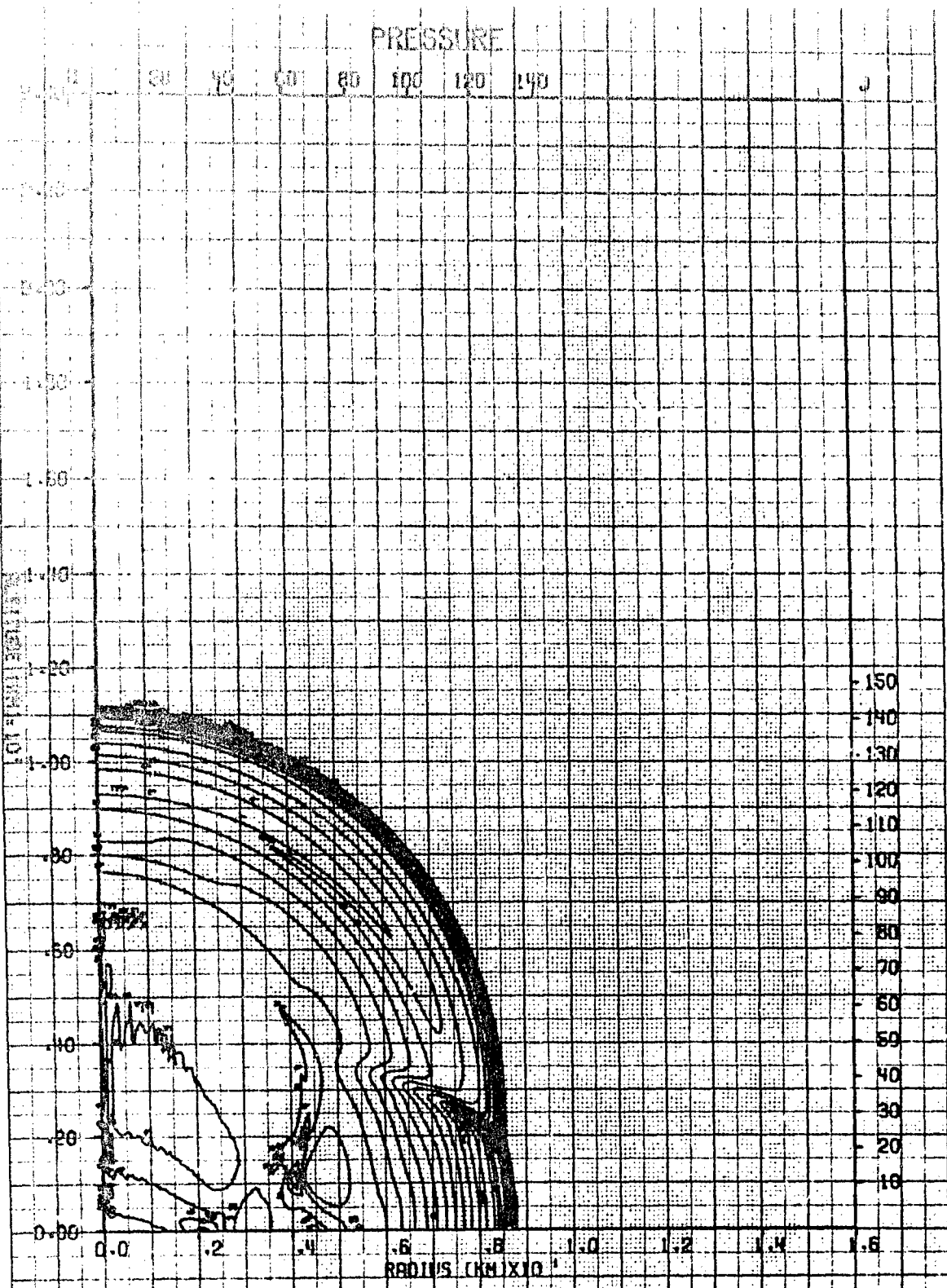
TIME .085 SEC

CYCLE 477

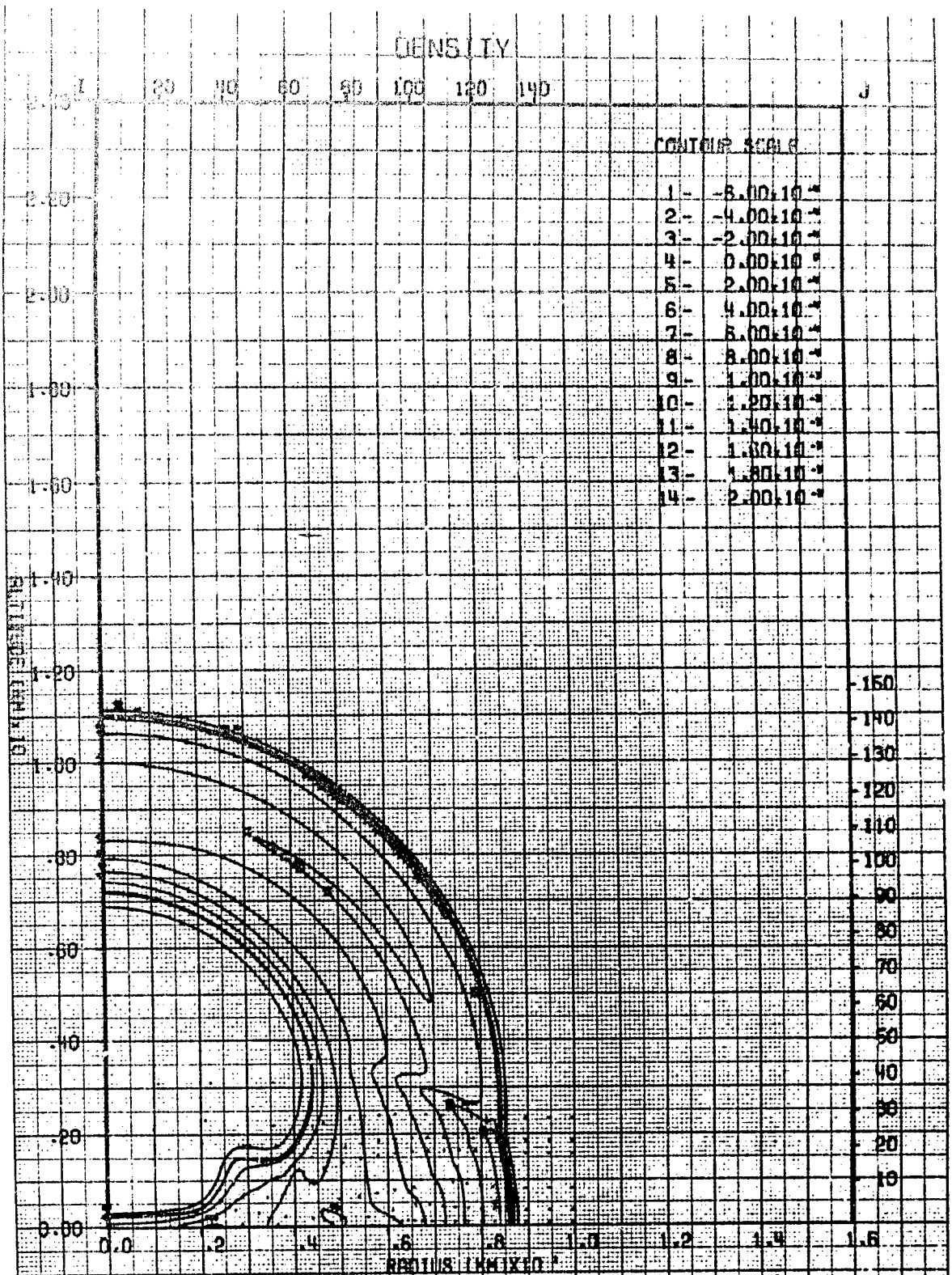
PROBLEM 201.004

✓





AFNL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.
 TIME .120 SEC CYCLE 599 PROBLEM 201.009 2/



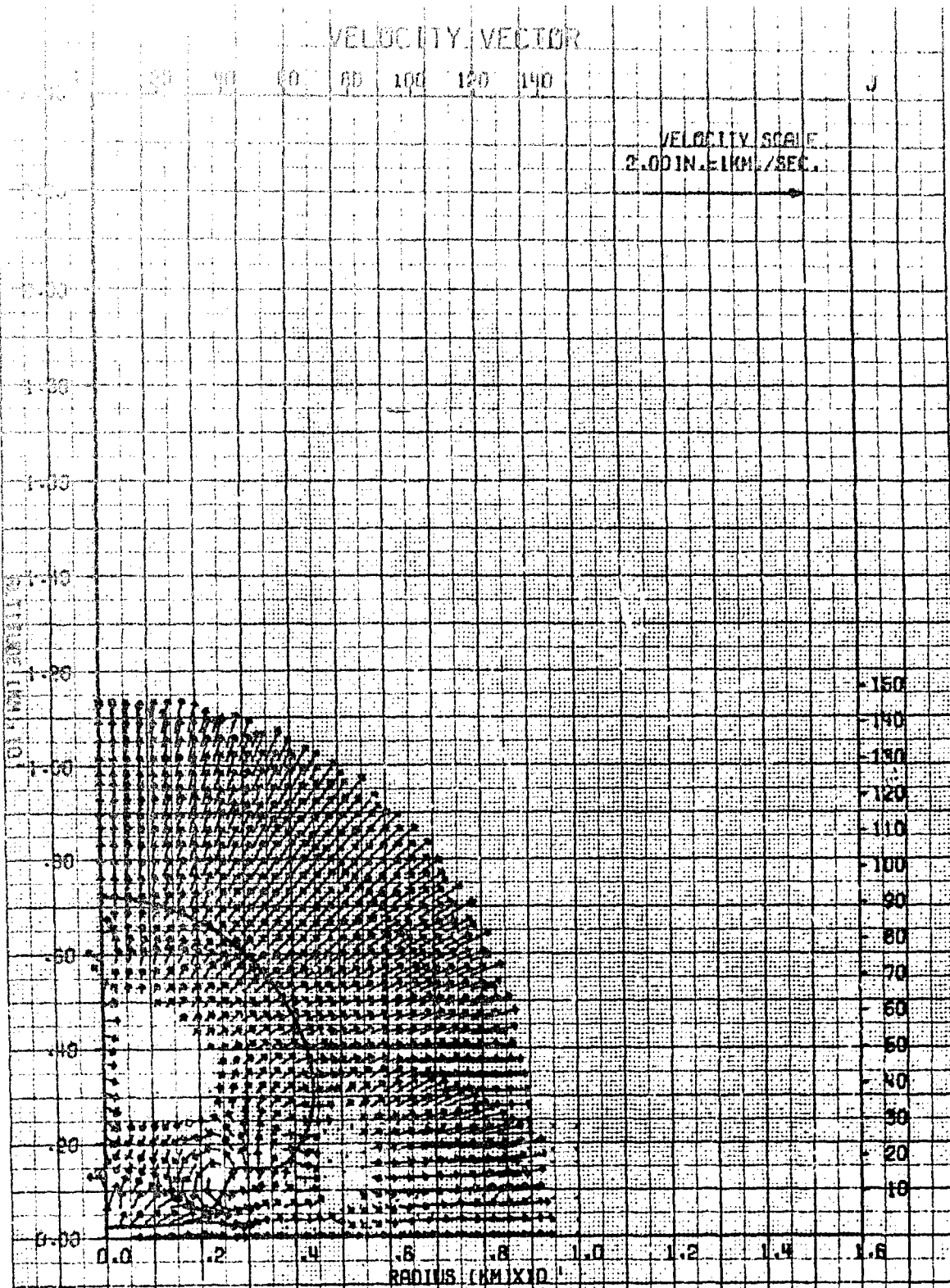
API SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.

TIME .120 SEC

CYCLE 599.

PROBLEM 201.004

24

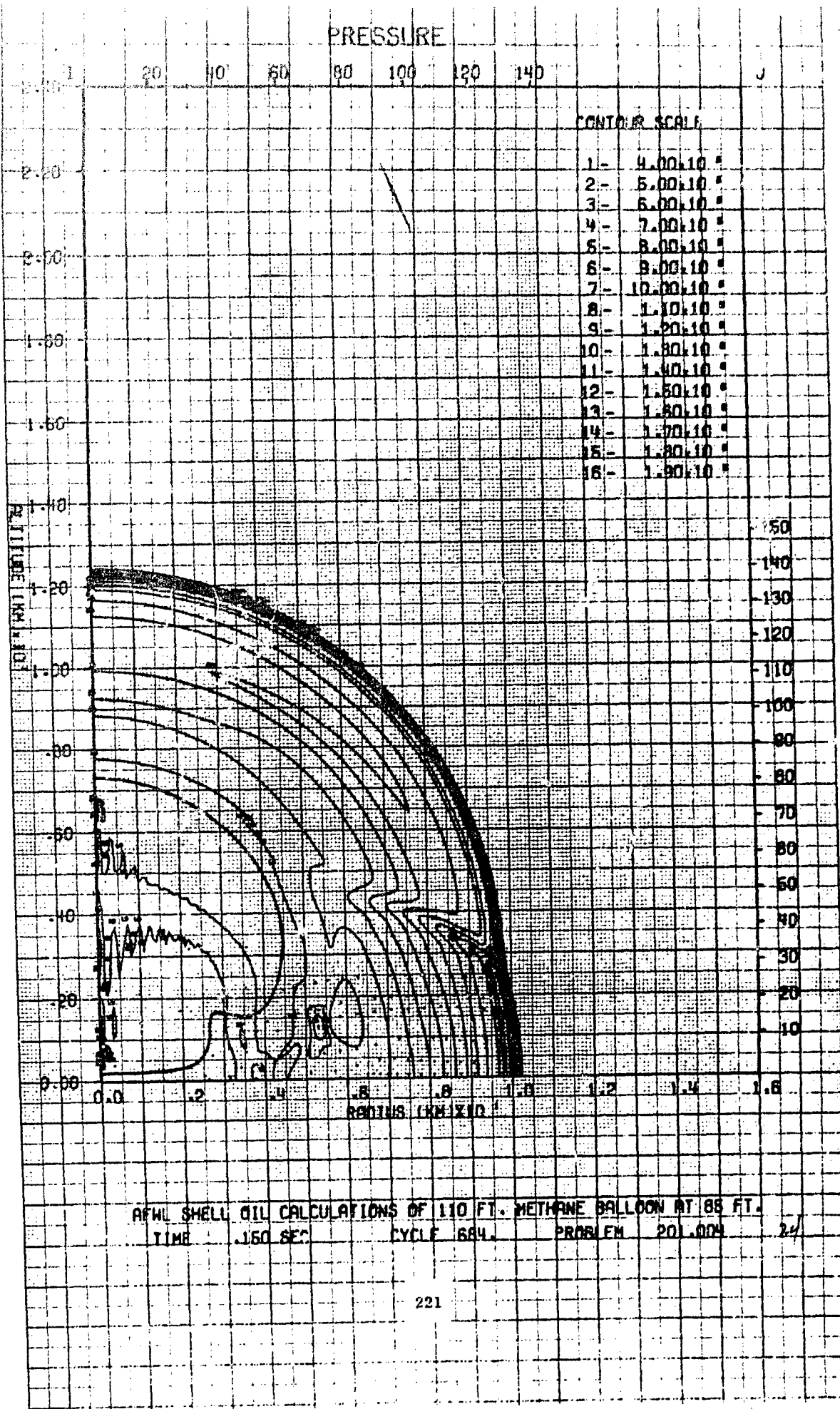


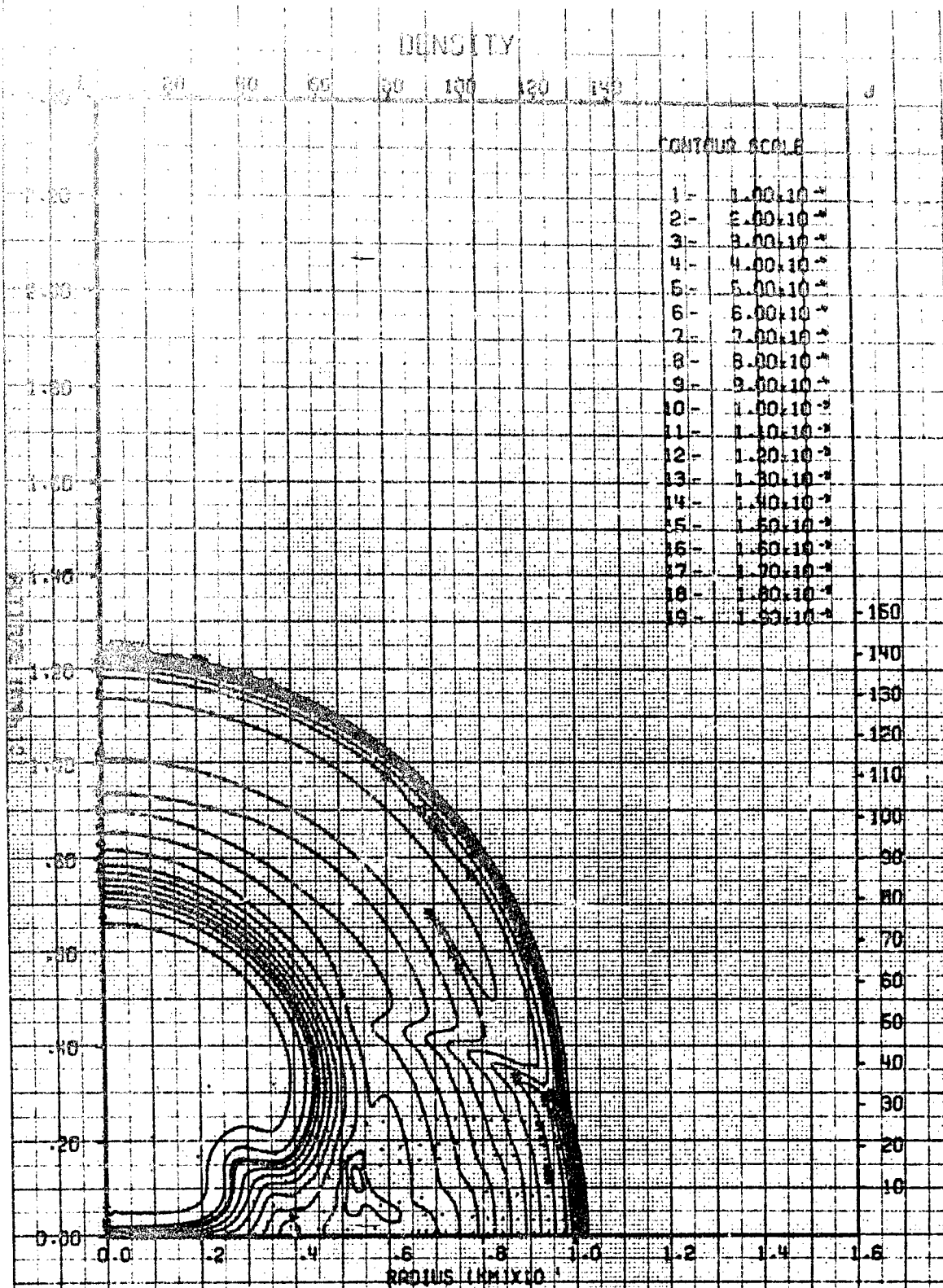
AFHL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.

TIME .120 SEC

CYCLE 599

PROBLEM 201.004





AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 88 FT.

TIME

150 SEC

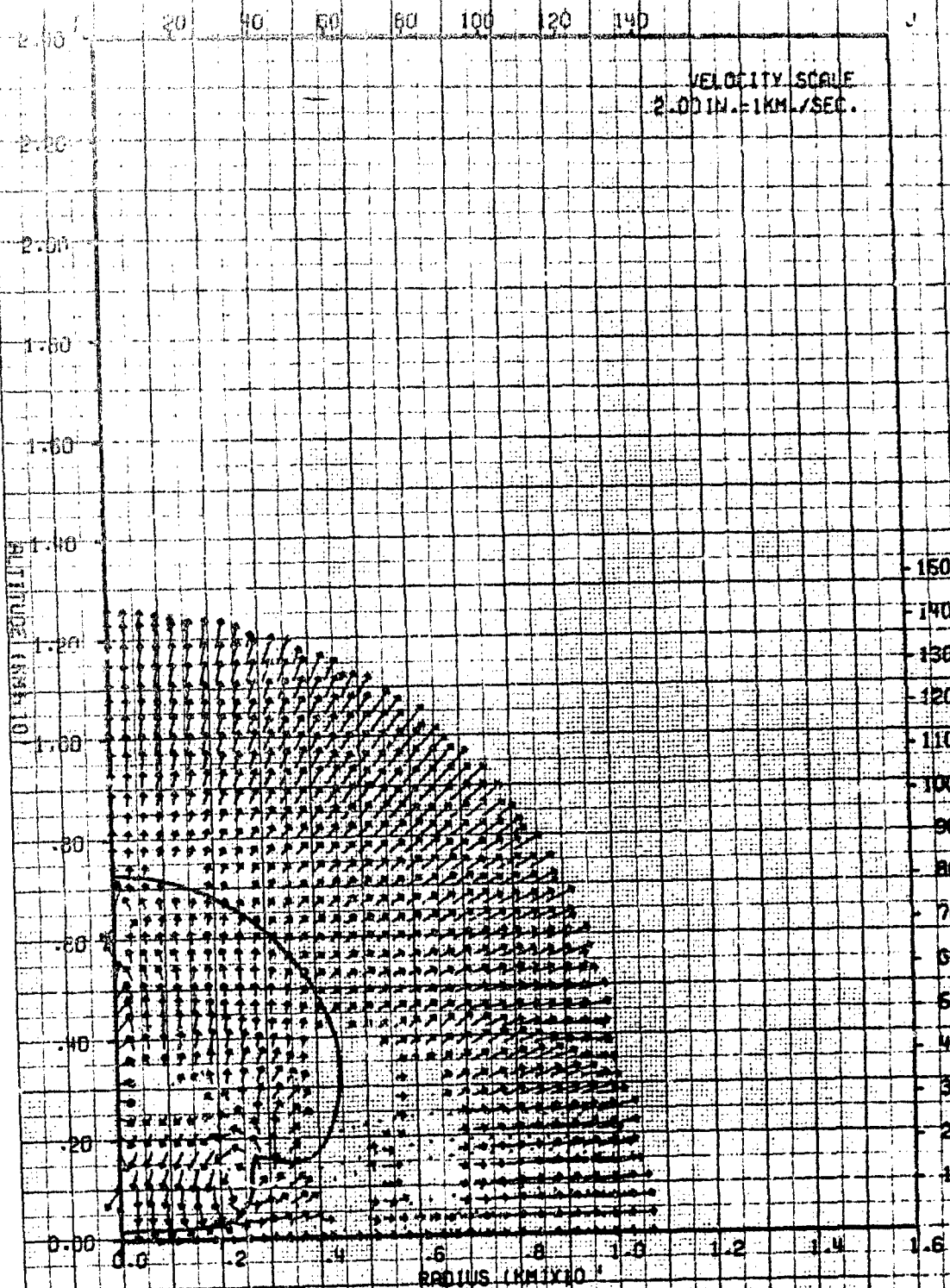
CYCLE 684

PROBLEM

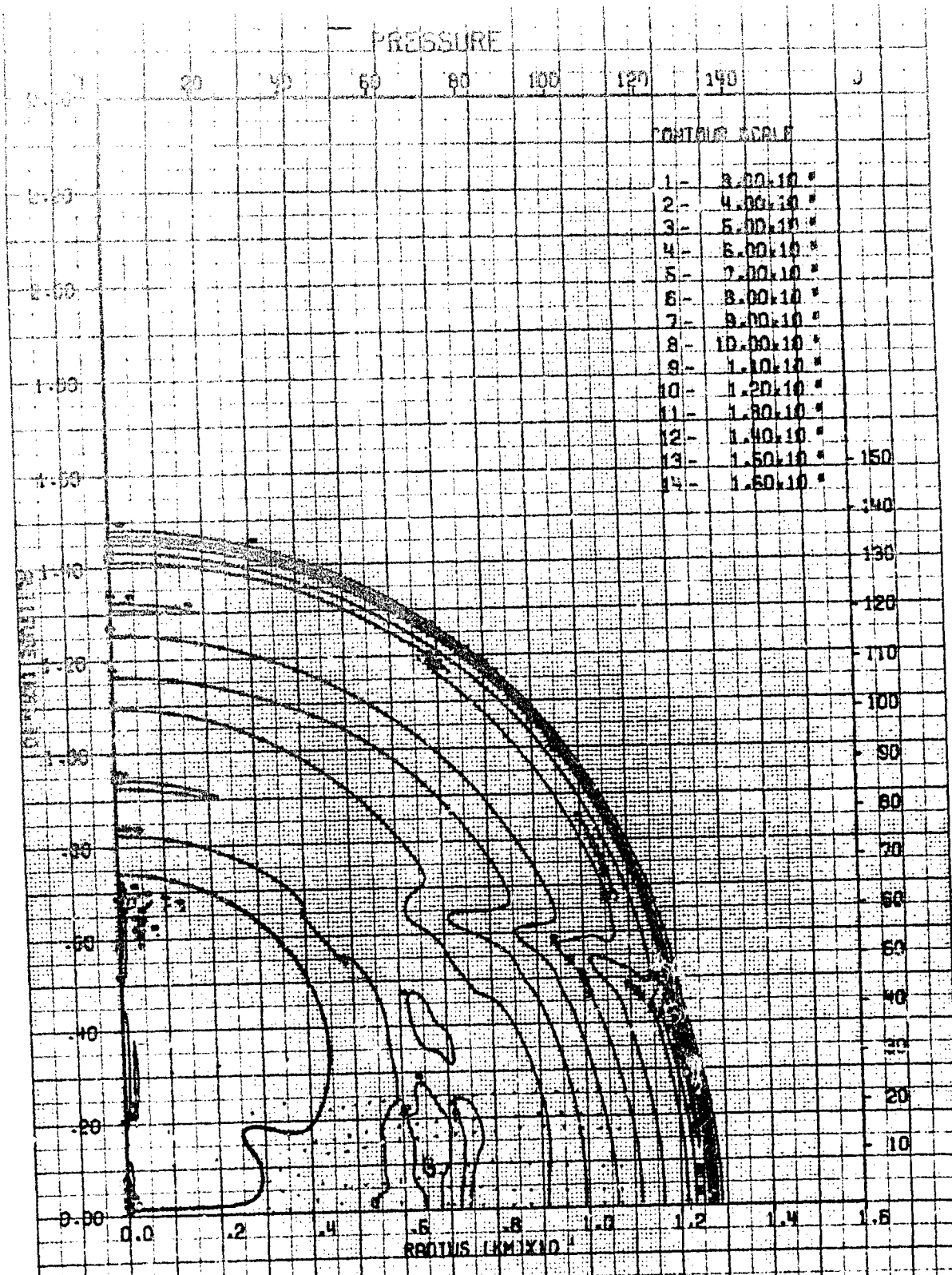
201.004

25

VELOCITY VECTOR



ATM. SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 88 FT.
 TIME 150 SEC CYCLE 684 PROBLEM 20.009 26



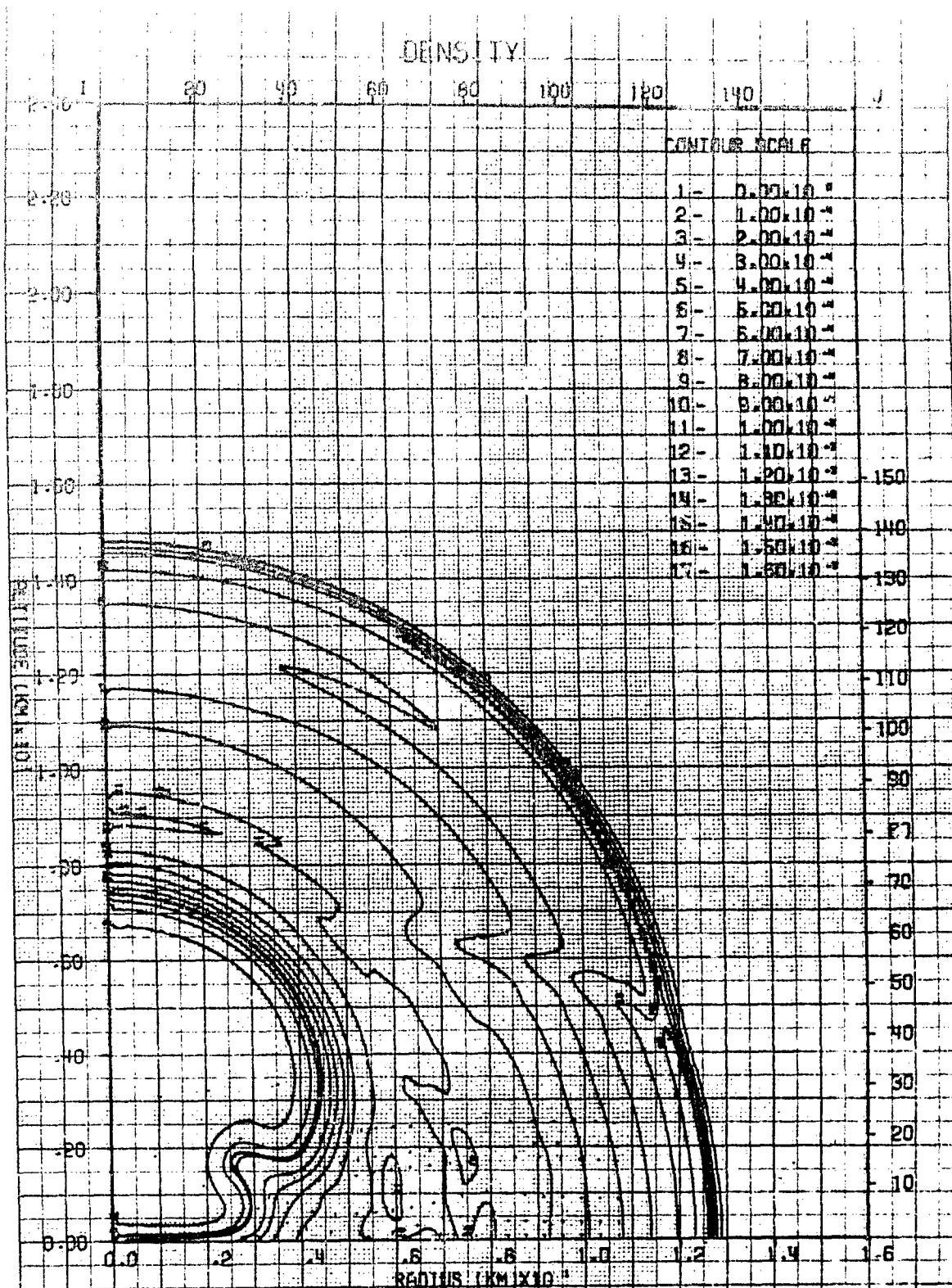
AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.

TIME 210 SEC

CYCLE 1824

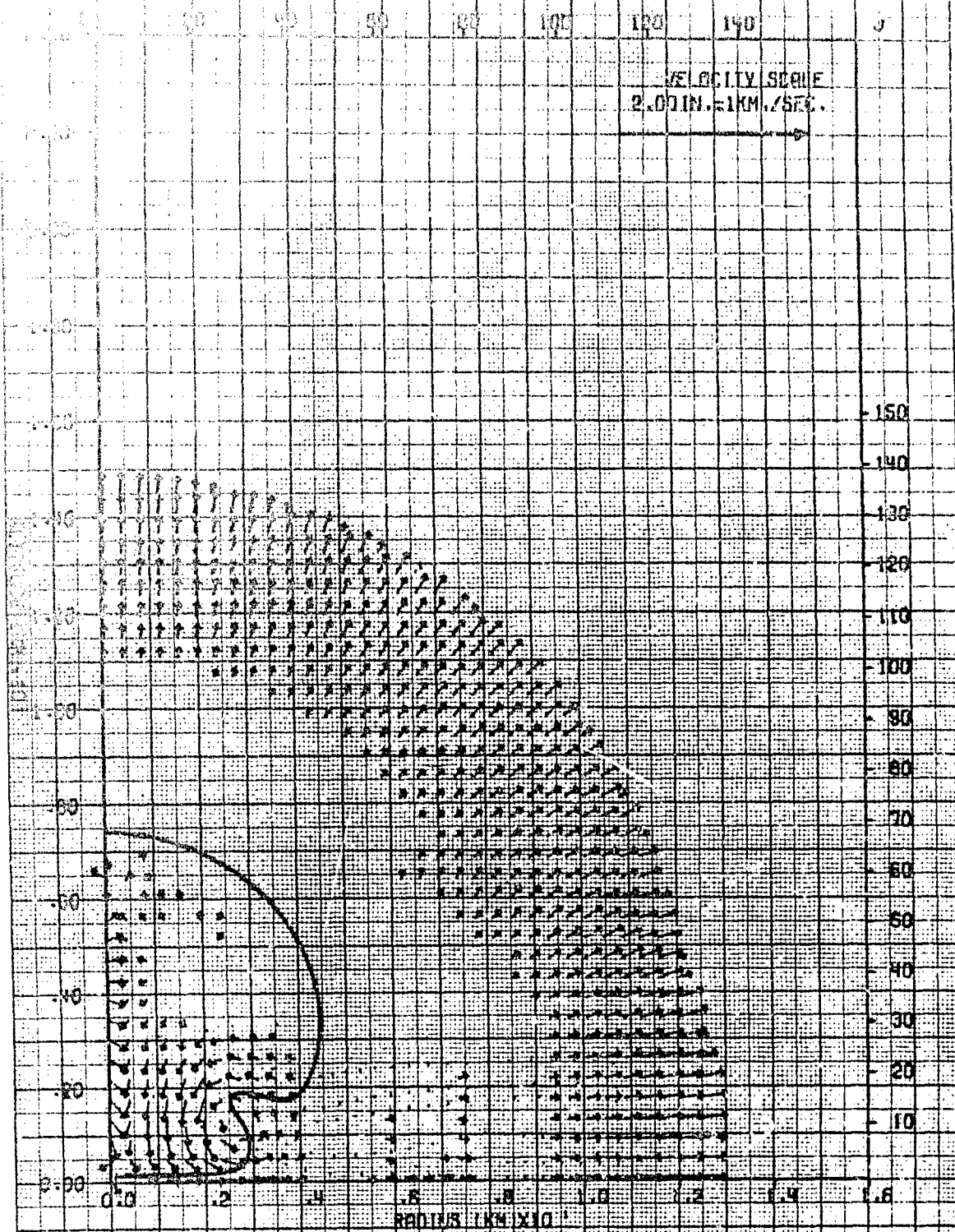
PROBLEMS 201.004

27



AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 85 FT.
 TIME 210 SEC CYCLE 824 PROBLEM 20.004 28

VELOCITY VECTOR



AFWL SHELL OIL CALCULATIONS OF 110 FT. METHANE BALLOON AT 88 FT.

TIME .210 SEC

CYCLE 824

PROBLEM 201.009

29

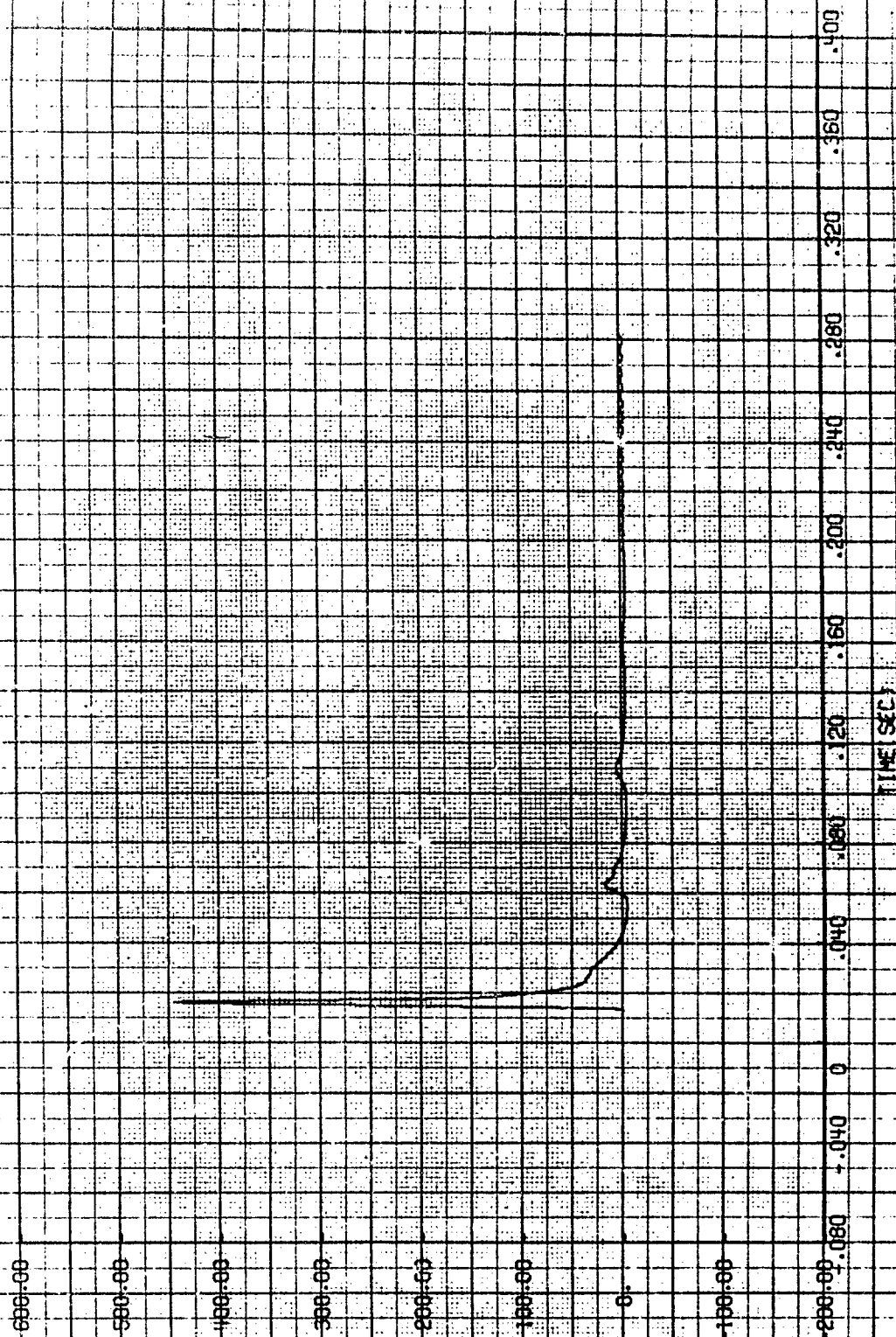
SHELL Tracings

This part contains the tracings recorded at each test station of overpressure, dynamic pressure overpressure impulse, dynamic pressure impulse and velocity resulting from the methane detonation. These are SHELL-OIL results.

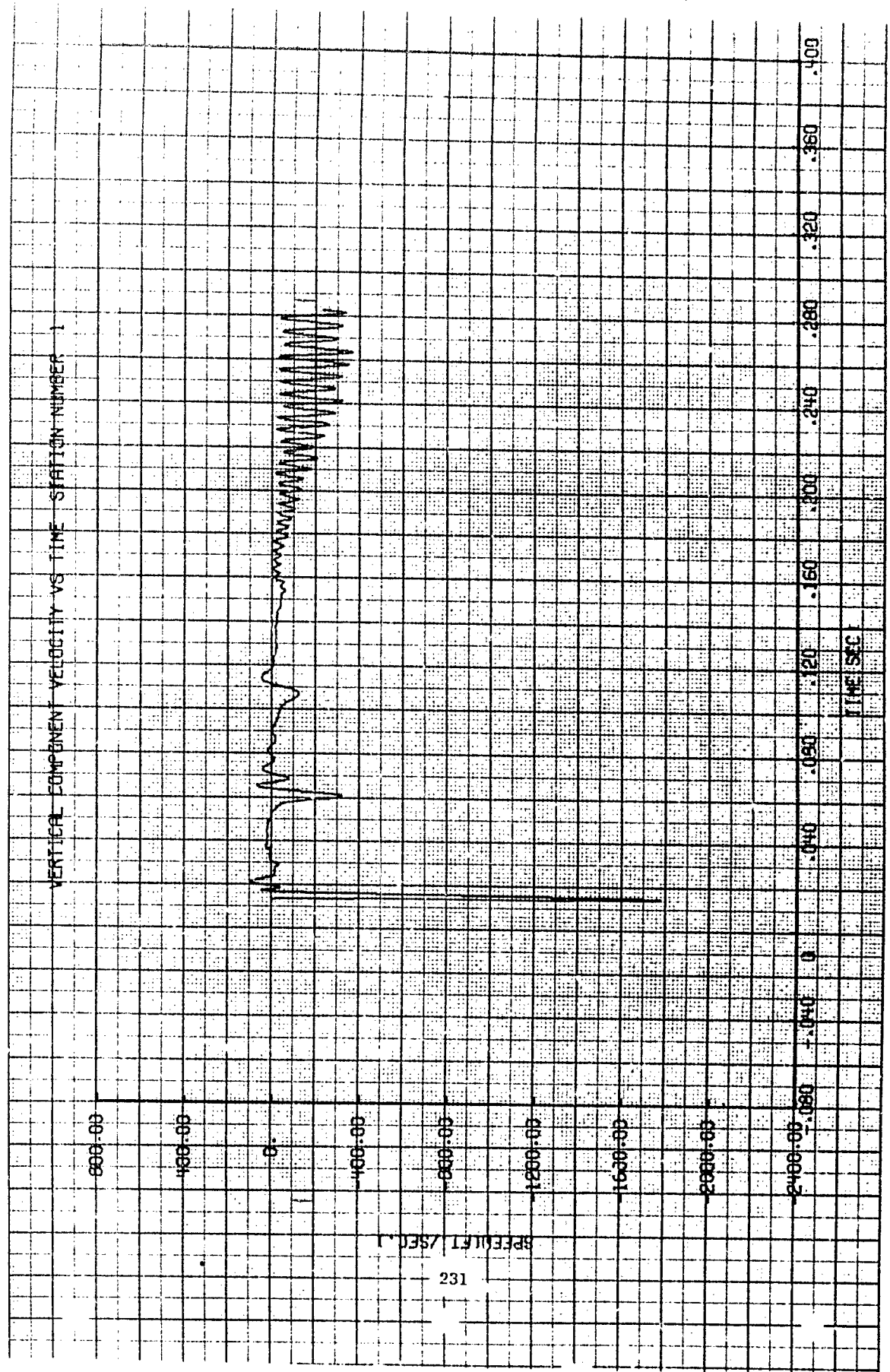
Table I gives the location of each test station.

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OVER PRESSURE VS TIME STATION NUMBER 1





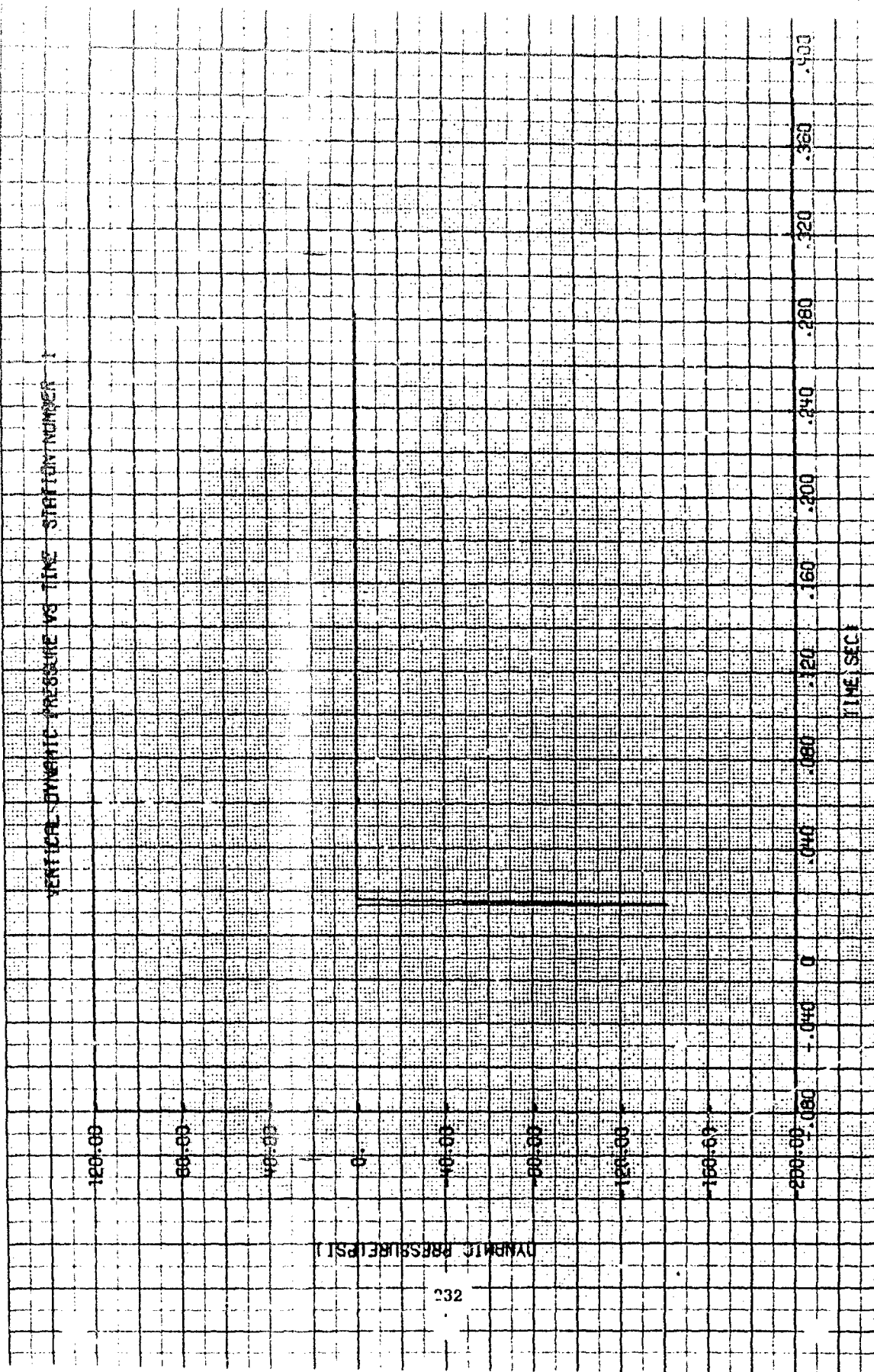


VERTICAL DYNAMIC PRESSURE VS TIME STATION NUMBER 1

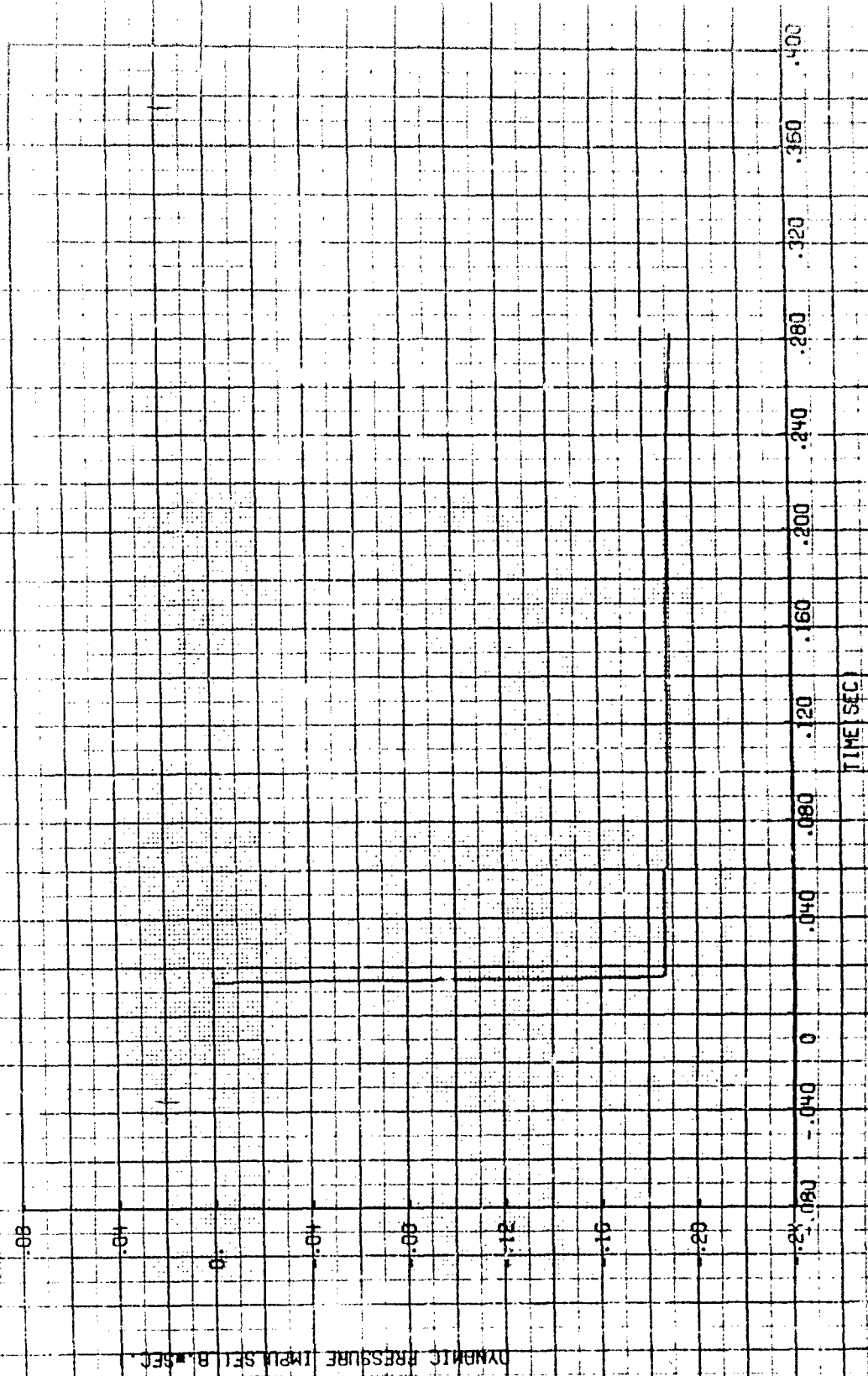
DYNAMIC PRESSURE (PSI)

232

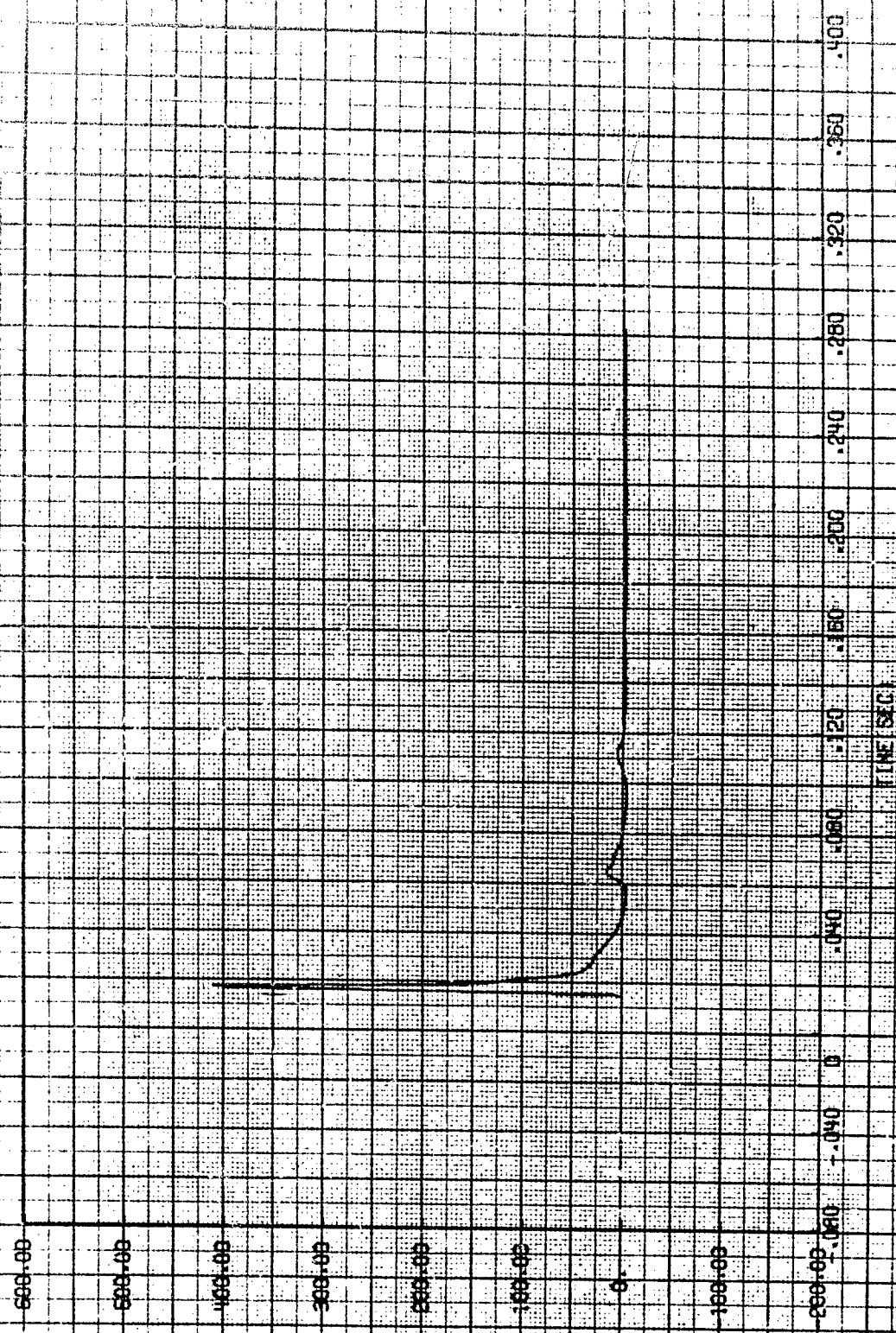
TIME (SEC)



VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME - STATION NUMBER 1

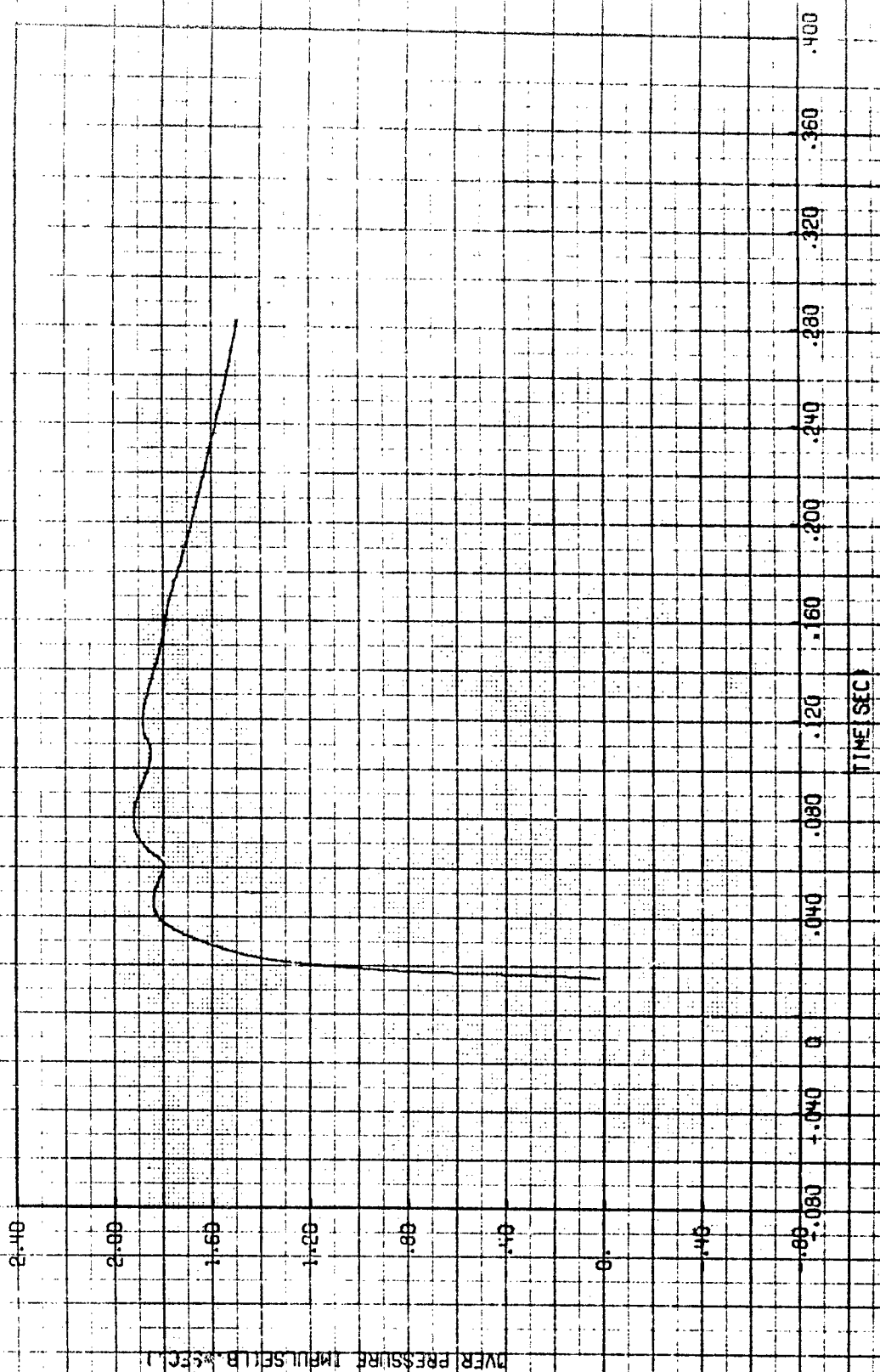


OVER PRESSURE VS TIME STATION NUMBER 2



OVER PRESSURE (PSI)

OVER PRESSURE IMPULSE VS TIME STATION NUMBER 2



HORIZONTAL COMPONENT VELOCITY VS TIME SECTION NUMBER 2

1400.00

1200.00

1000.00

800.00

600.00

400.00

200.00

0

-200.00

-400.00

-600.00

-800.00

-1000.00

-1200.00

-1400.00

-1600.00

-1800.00

-2000.00

SPEED (FT/SEC)

236

TIME (SEC)

0.00

0.02

0.04

0.06

0.08

0.10

0.12

0.14

0.16

0.18

0.20

0.22

0.24

0.26

0.28

0.30

0.32

0.34

0.36

0.38

0.40

0.42

0.44

0.46

0.48

0.50

0.52

0.54

0.56

0.58

0.60

0.62

0.64

0.66

0.68

0.70

0.72

0.74

0.76

0.78

0.80

0.82

0.84

0.86

0.88

0.90

0.92

0.94

0.96

0.98

1.00

1.02

1.04

1.06

1.08

1.10

1.12

1.14

1.16

1.18

1.20

1.22

1.24

1.26

1.28

1.30

1.32

1.34

1.36

1.38

1.40

1.42

1.44

1.46

1.48

1.50

1.52

1.54

1.56

1.58

1.60

1.62

1.64

1.66

1.68

1.70

1.72

1.74

1.76

1.78

1.80

1.82

1.84

1.86

1.88

1.90

1.92

1.94

1.96

1.98

2.00

2.02

2.04

2.06

2.08

2.10

2.12

2.14

2.16

2.18

2.20

2.22

2.24

2.26

2.28

2.30

2.32

2.34

2.36

2.38

2.40

2.42

2.44

2.46

2.48

2.50

2.52

2.54

2.56

2.58

2.60

2.62

2.64

2.66

2.68

2.70

2.72

2.74

2.76

2.78

2.80

2.82

2.84

2.86

2.88

2.90

2.92

2.94

2.96

2.98

3.00

3.02

3.04

3.06

3.08

3.10

3.12

3.14

3.16

3.18

3.20

3.22

3.24

3.26

3.28

3.30

3.32

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3.36

3.38

3.40

3.42

3.44

3.46

3.48

3.50

3.52

3.54

3.56

3.58

3.60

3.62

3.64

3.66

3.68

3.70

3.72

3.74

3.76

3.78

3.80

3.82

3.84

3.86

3.88

3.90

3.92

3.94

3.96

3.98

4.00

4.02

4.04

4.06

4.08

4.10

4.12

4.14

4.16

4.18

4.20

4.22

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4.48

4.50

4.52

4.54

4.56

4.58

4.60

4.62

4.64

4.66

4.68

4.70

4.72

4.74

4.76

4.78

4.80

4.82

4.84

4.86

4.88

4.90

4.92

4.94

4.96

4.98

5.00

5.02

5.04

5.06

5.08

5.10

5.12

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5.22

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5.48

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5.52

5.54

5.56

5.58

5.60

5.62

5.64

5.66

5.68

5.70

5.72

5.74

5.76

5.78

5.80

5.82

5.84

5.86

5.88

5.90

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5.96

5.98

6.00

6.02

6.04

6.06

6.08

6.10

6.12

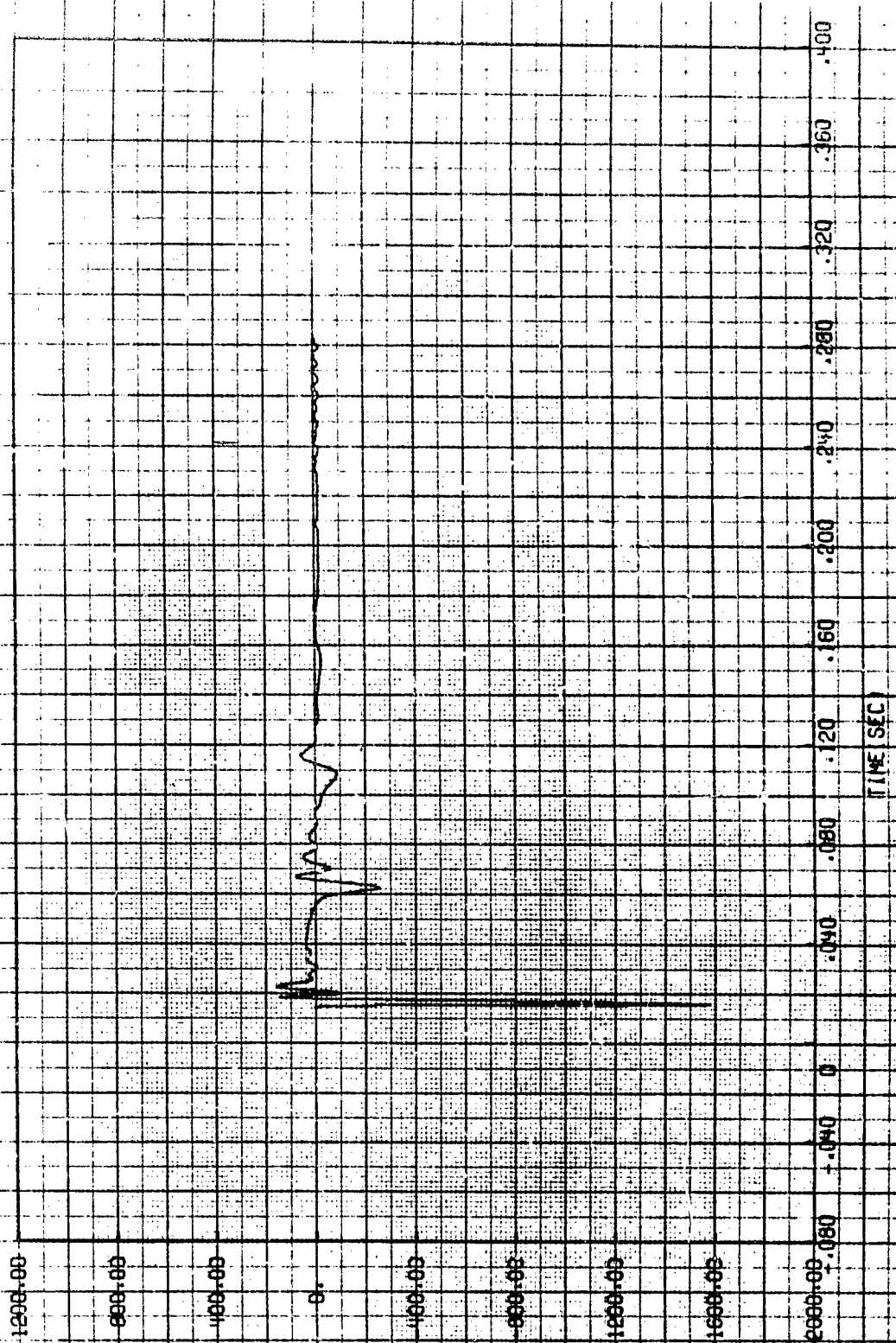
6.14

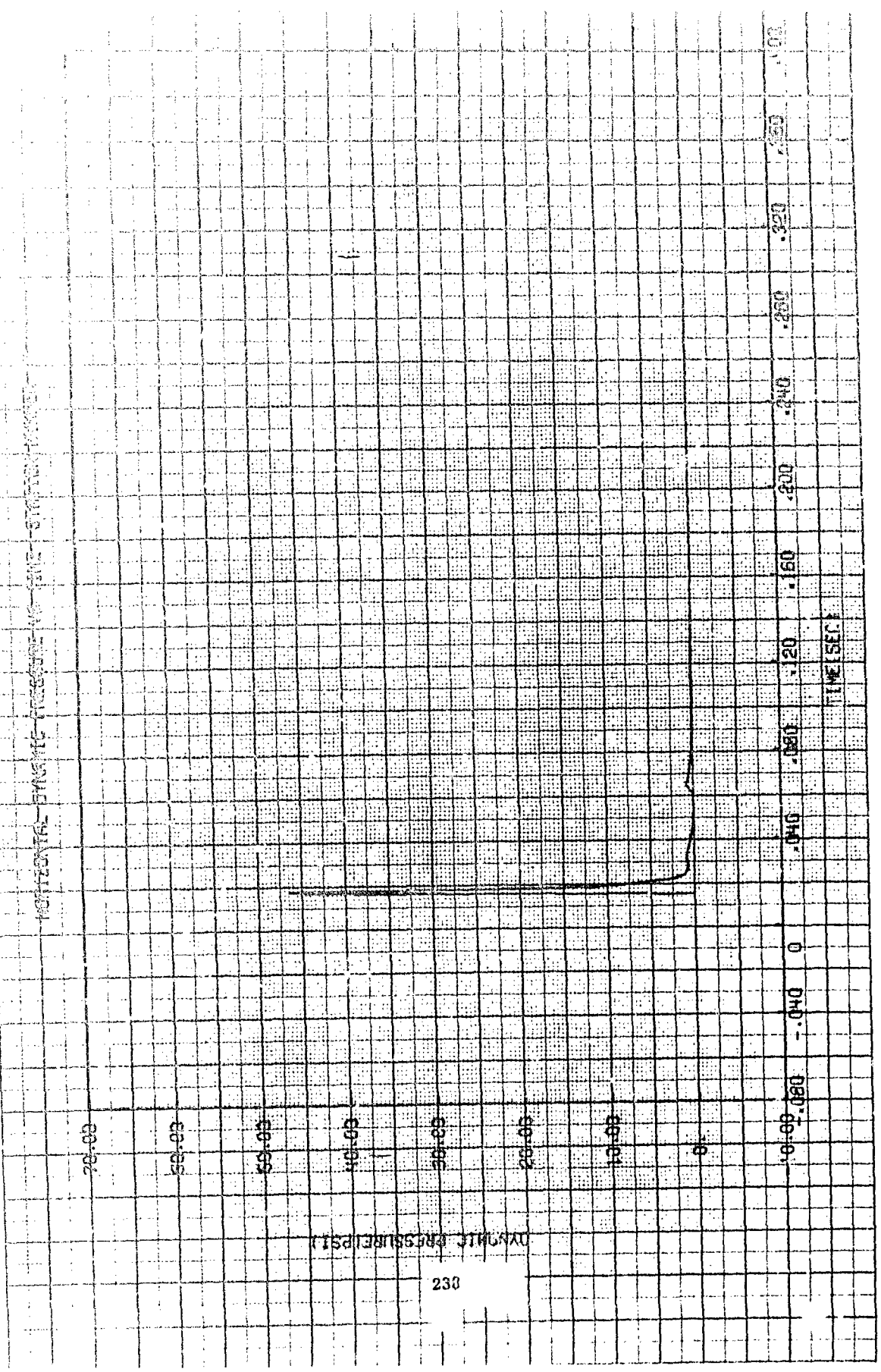
6.16

6.18

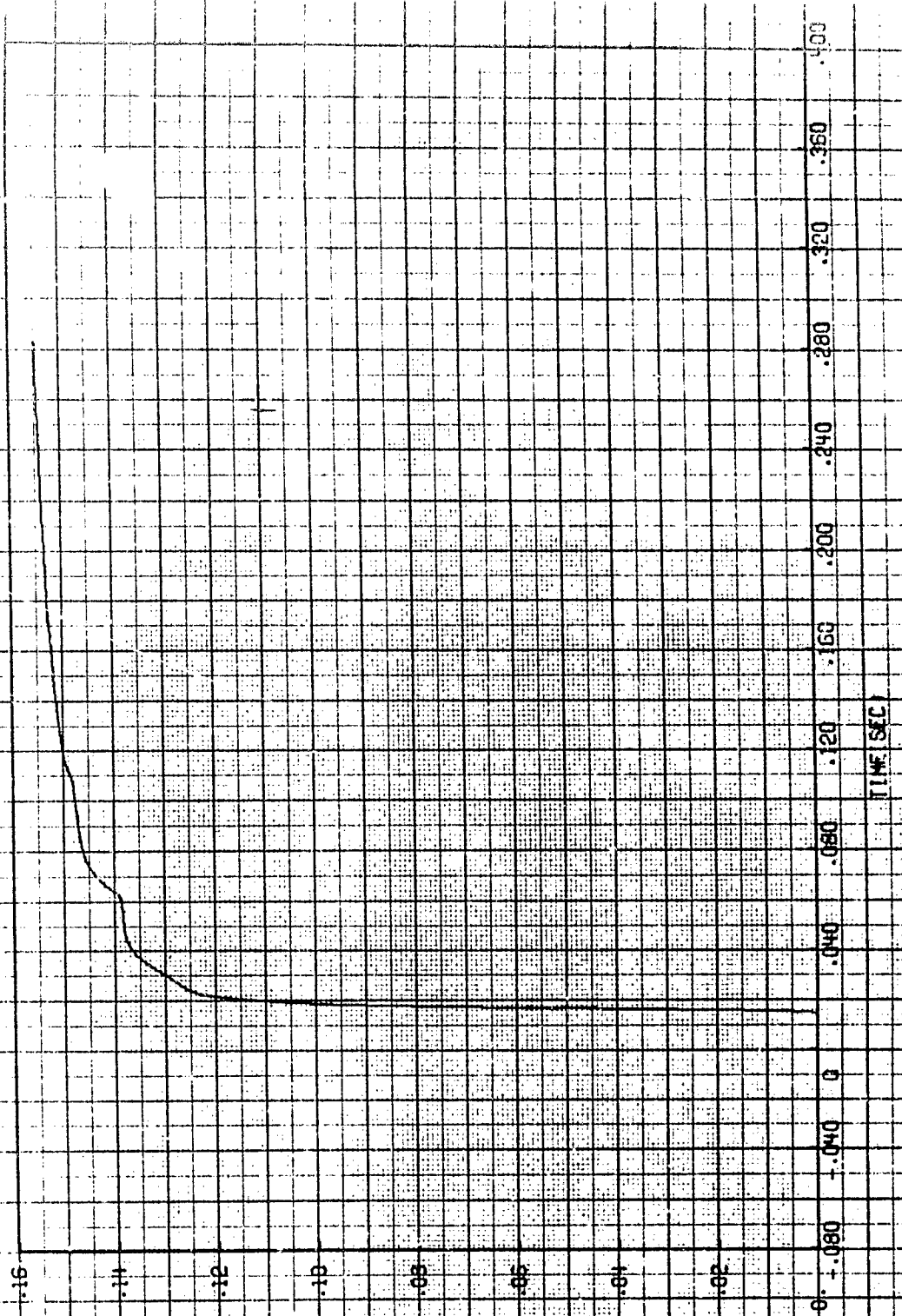
6.20

VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 2

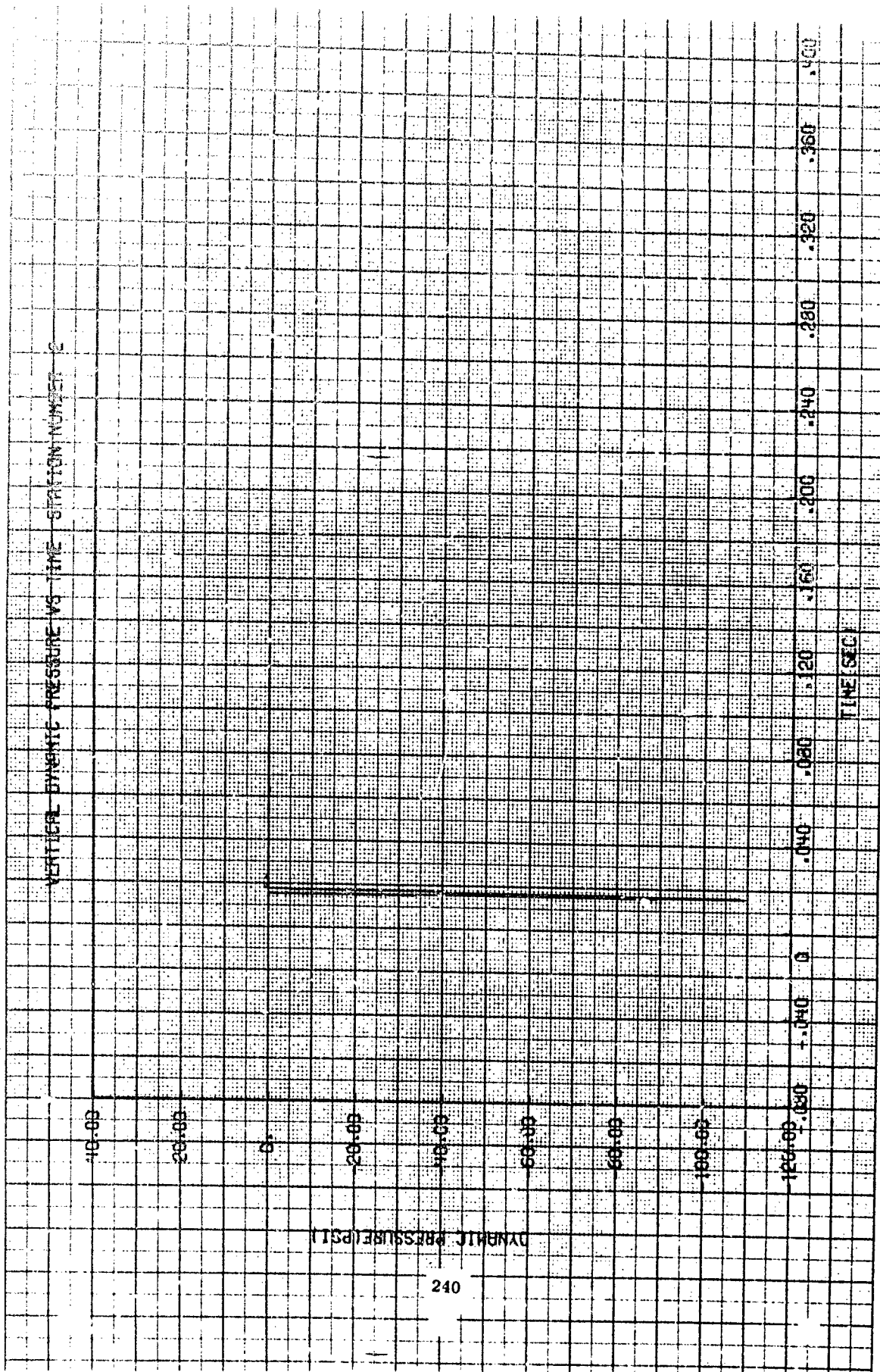




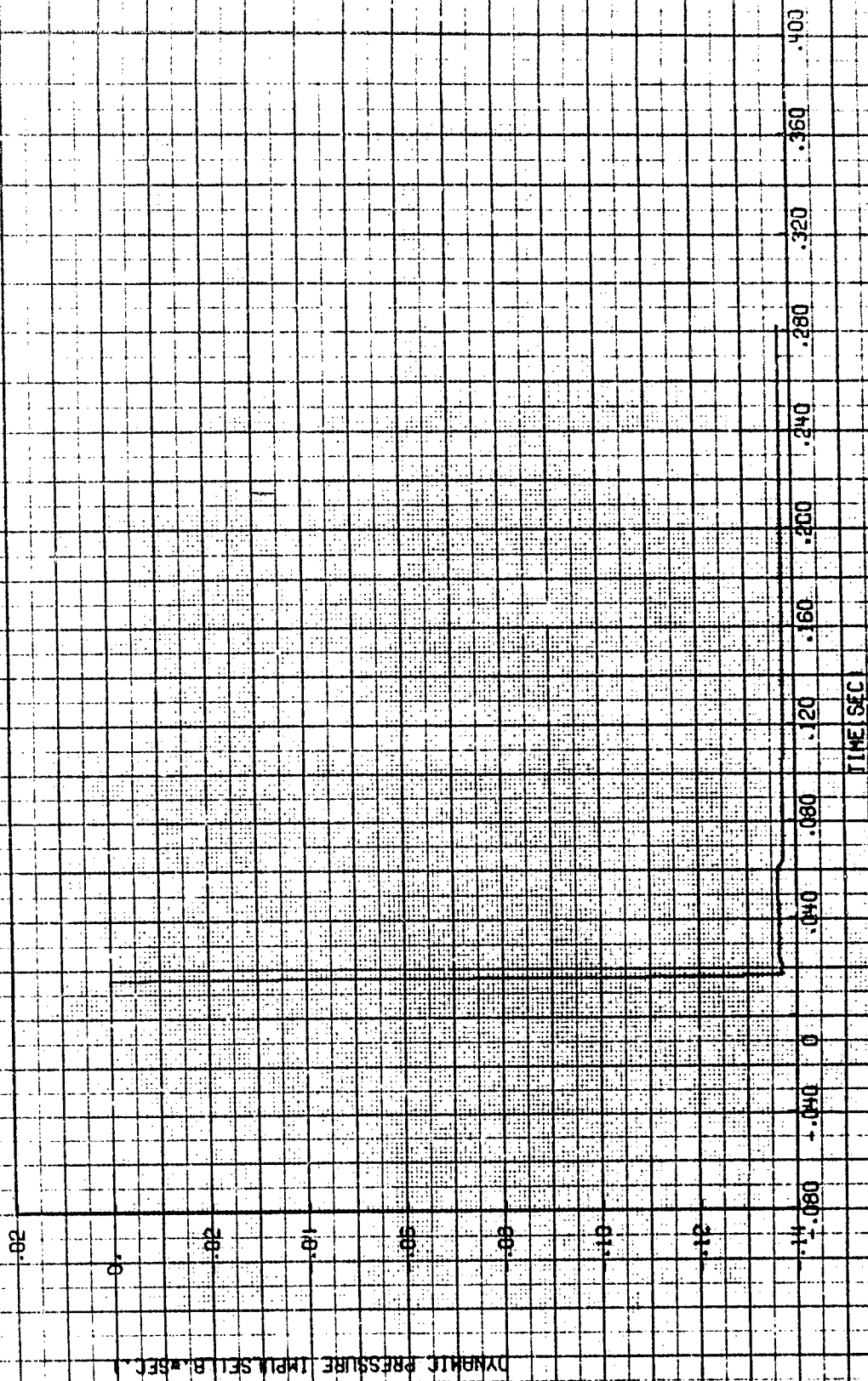
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 2



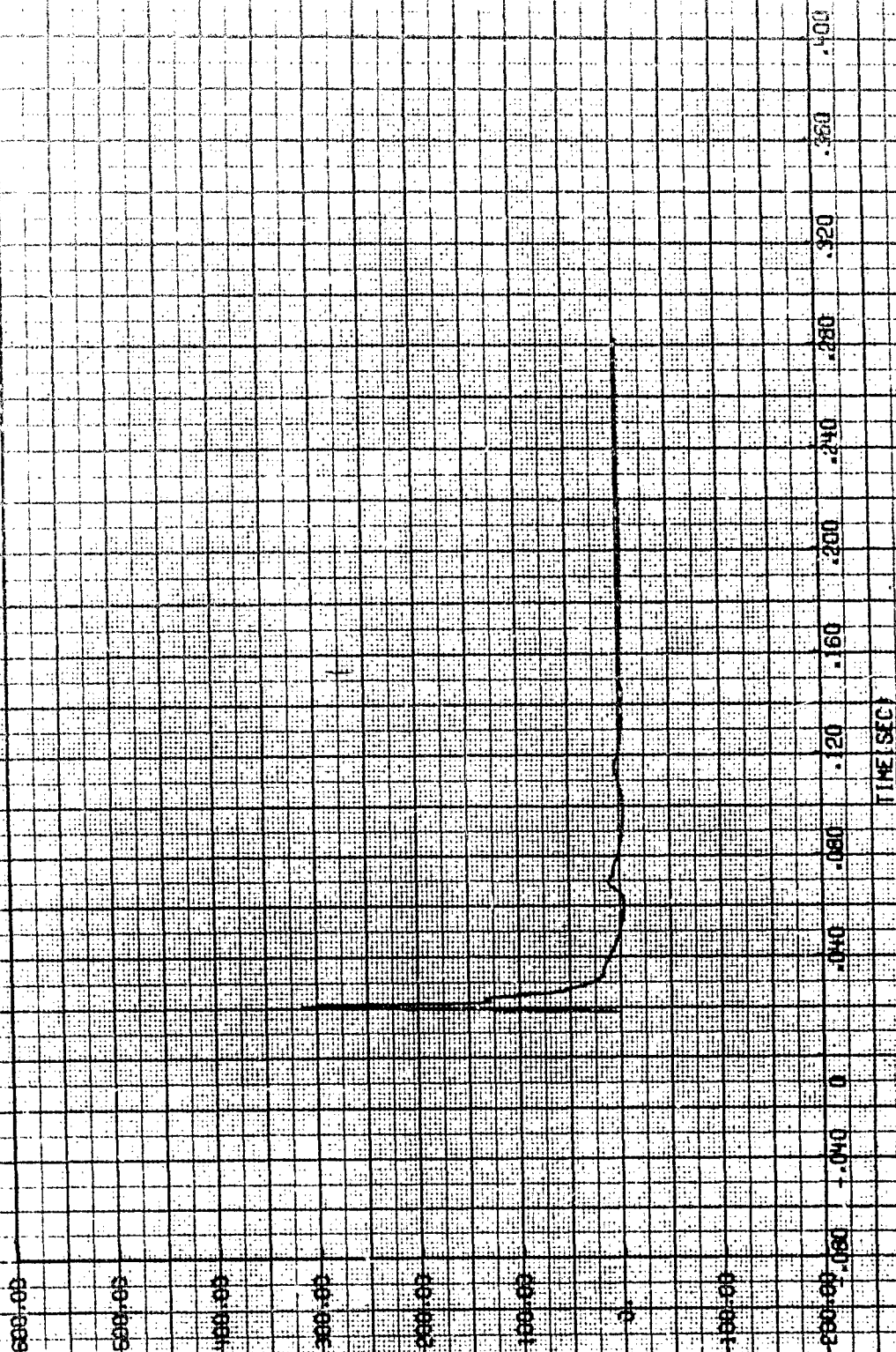
DYNAMIC PRESSURE IMPULSE LBS/SEC



VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 2

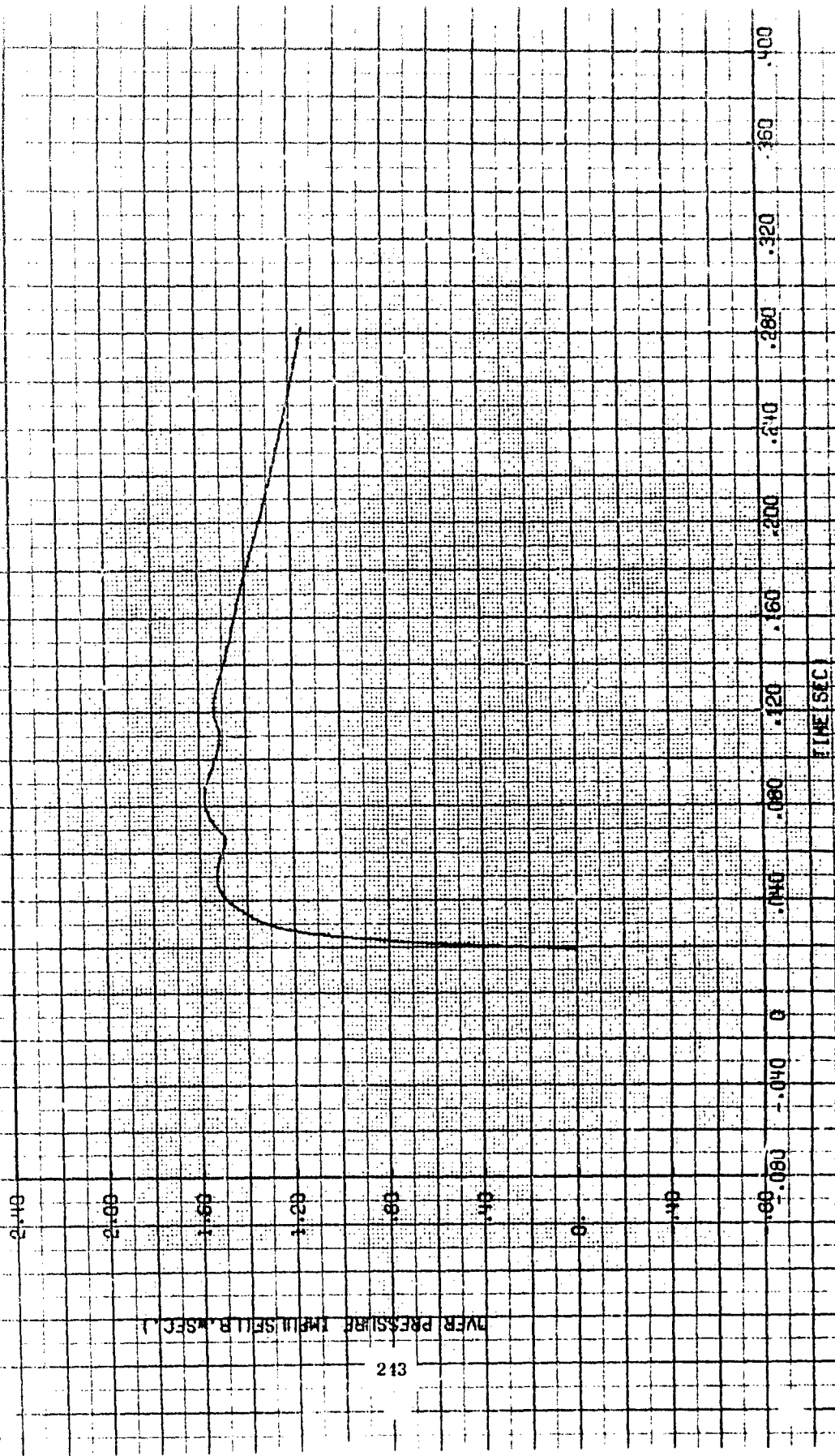


OVER PRESSURE VS TIME STATION NUMBER 3



OVER PRESSURE (PSI)

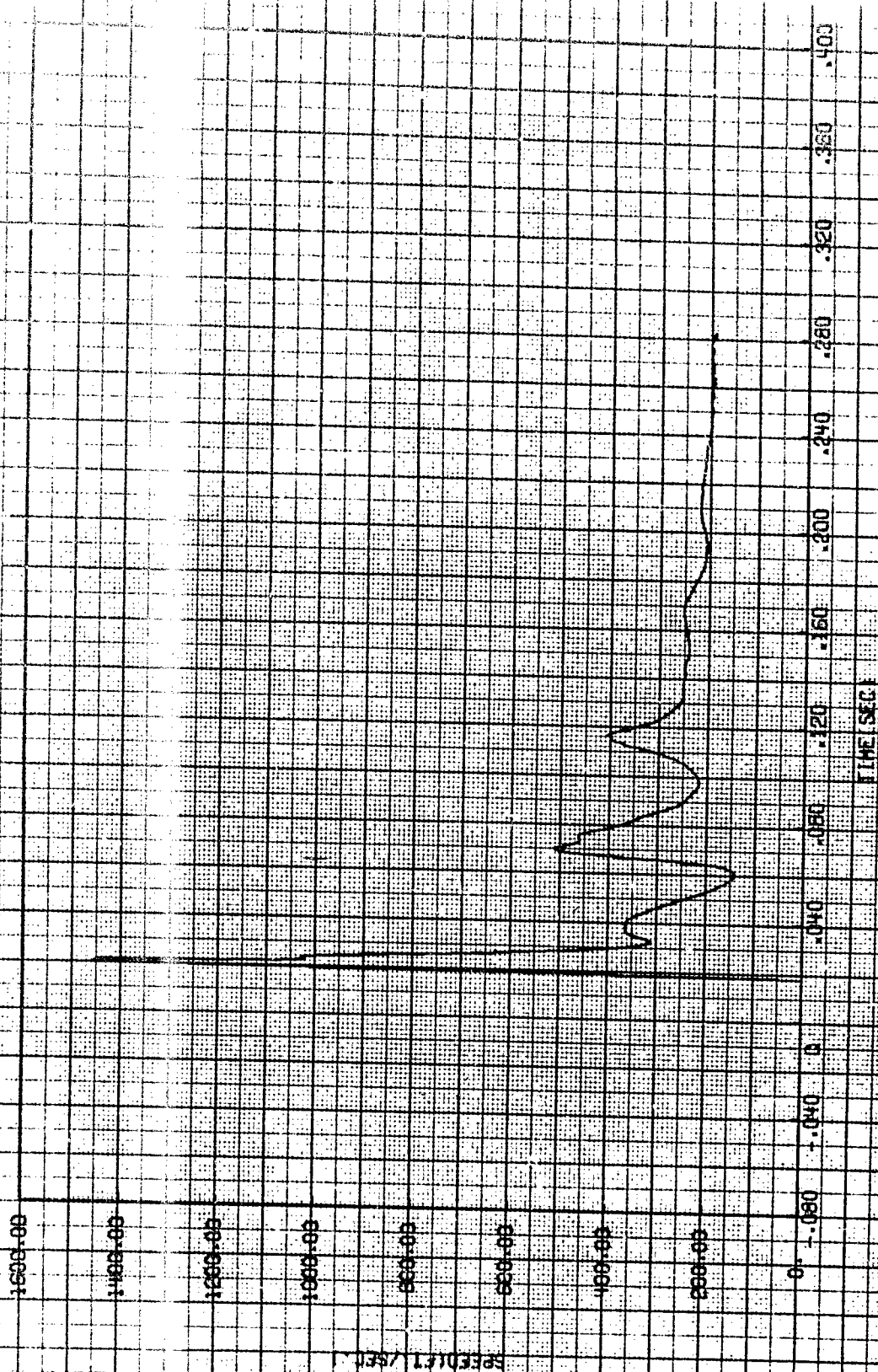
OVER PRESSURE IMPULSE VS TIME STATION NUMBER 3



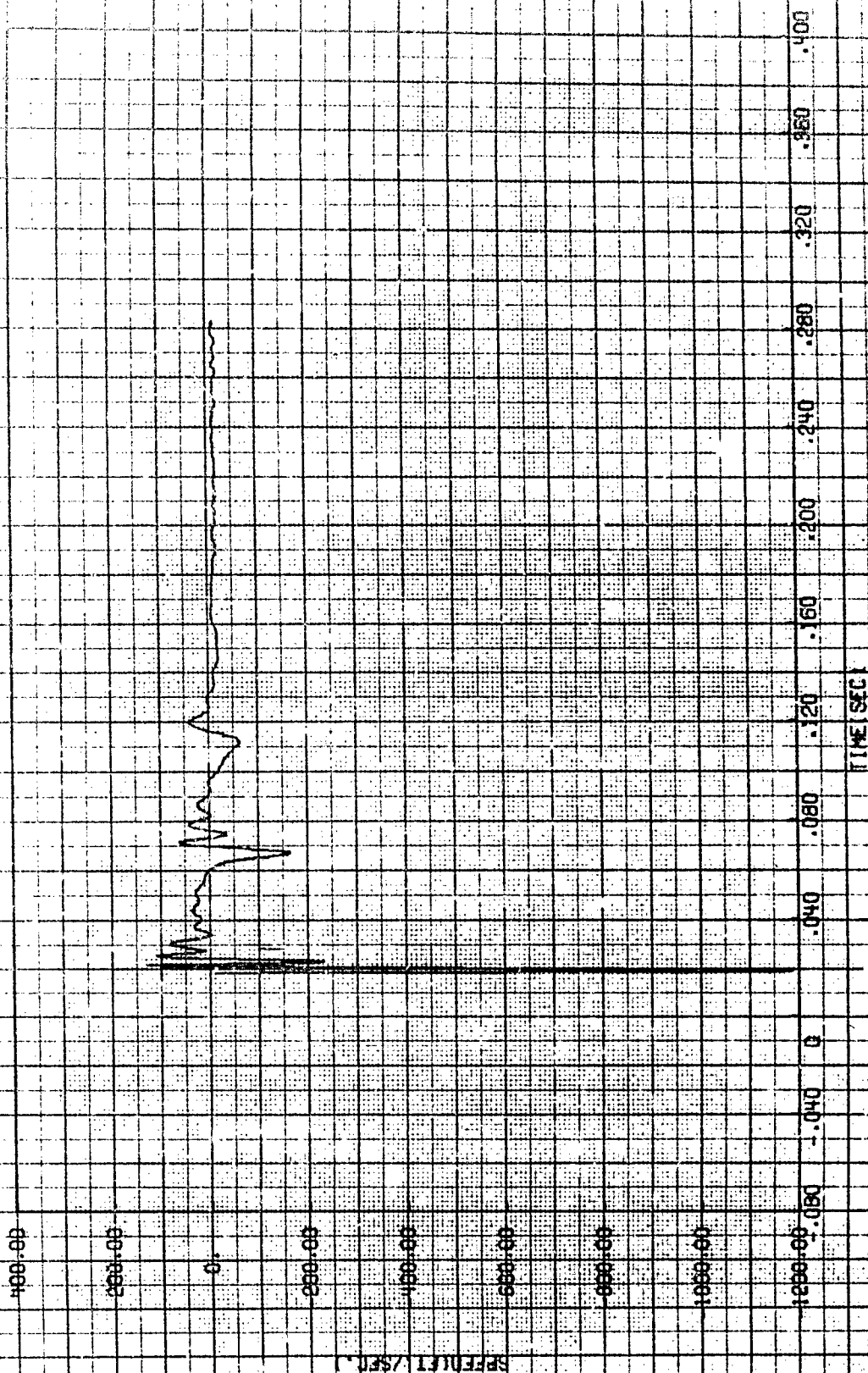
OVER PRESSURE IMPULSE (LB./SQ. IN. SEC.)

TIME (SEC)

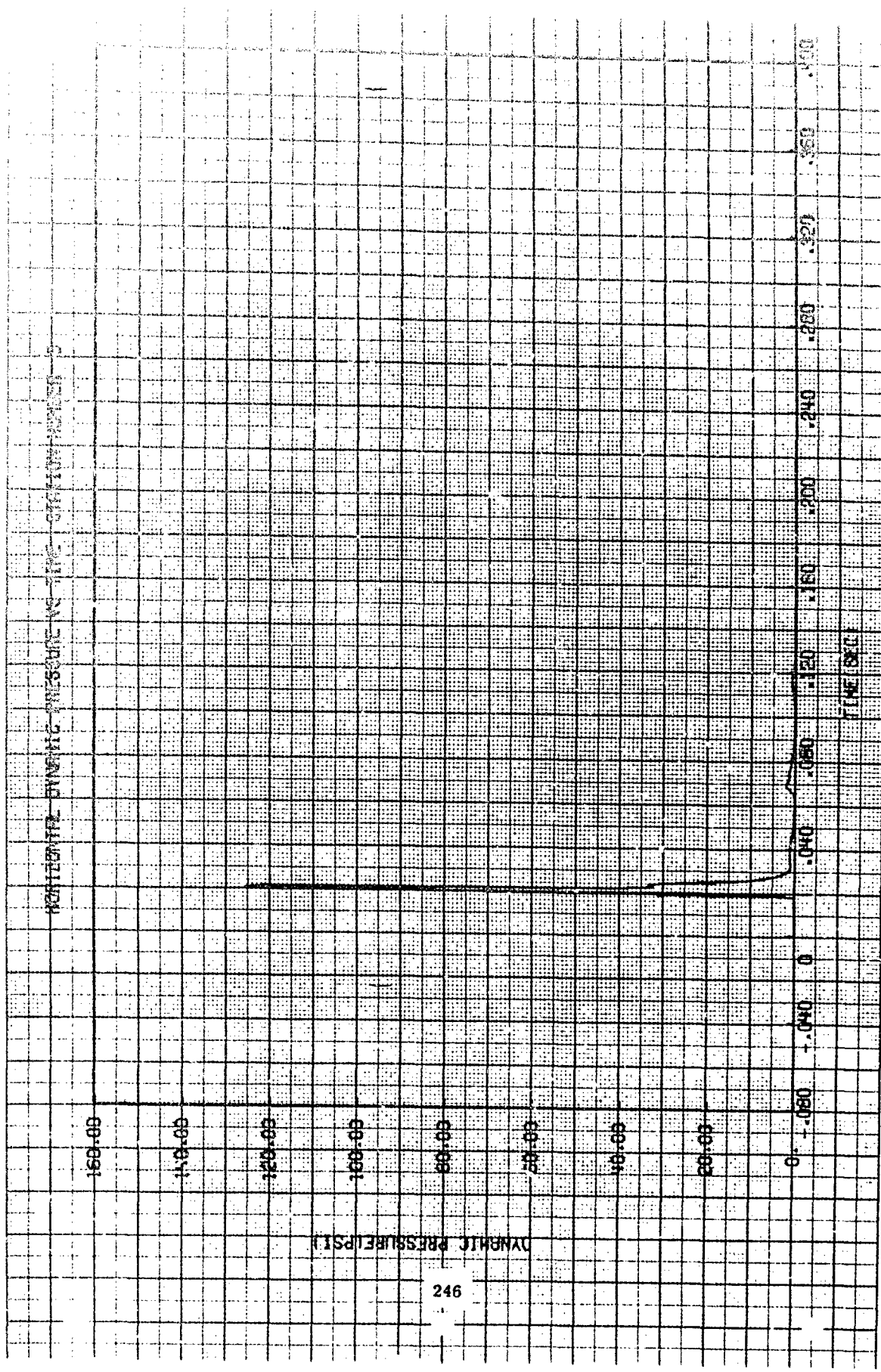
HORIZONTAL COMPONENT VELOCITY AT THE STATION NUMBER 5



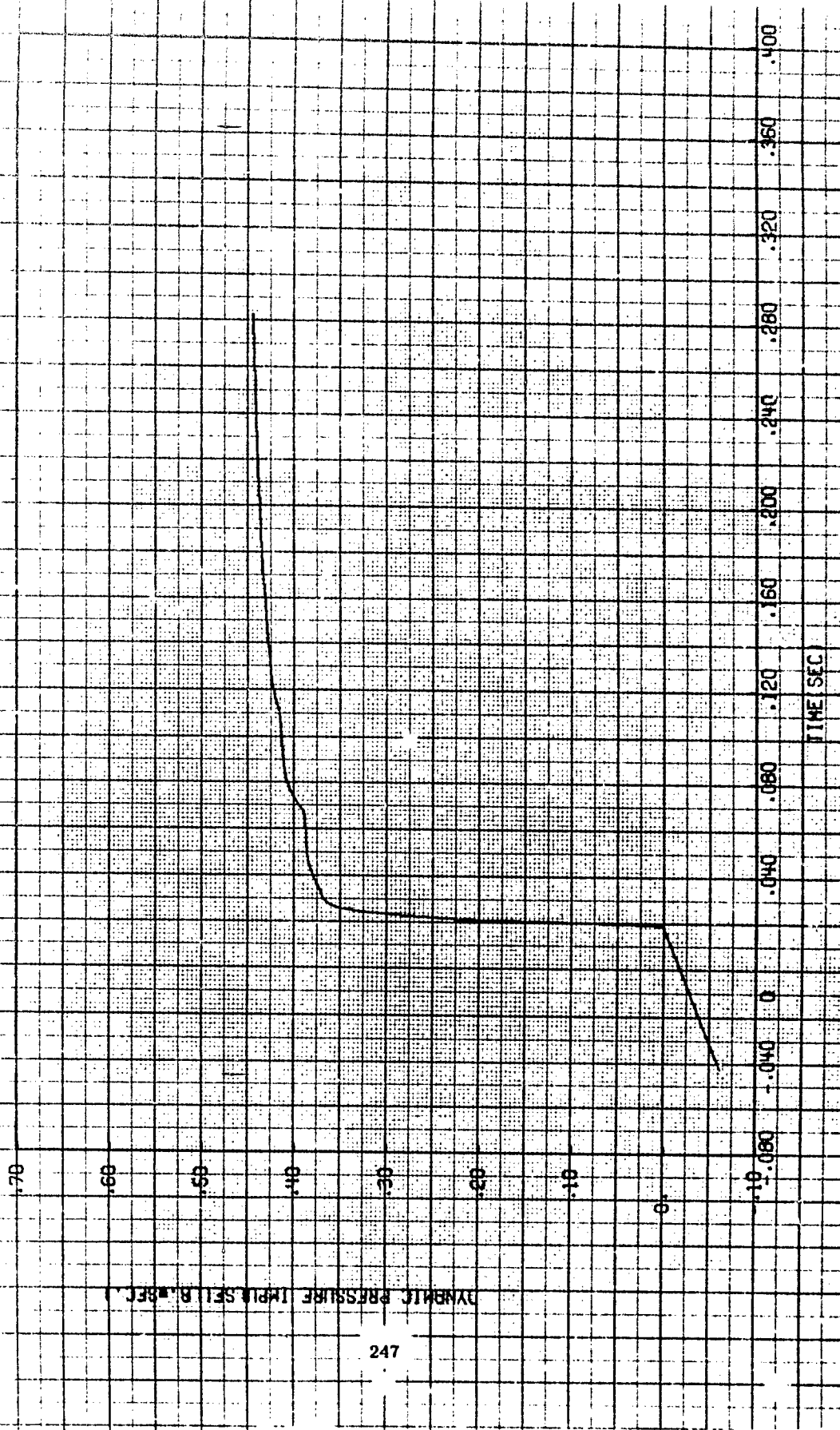
VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 3



VELOCITY (FT/SEC)



HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 3



VERTICAL DYNAMIC PRESSURE VS TIME STATION NUMBER 5

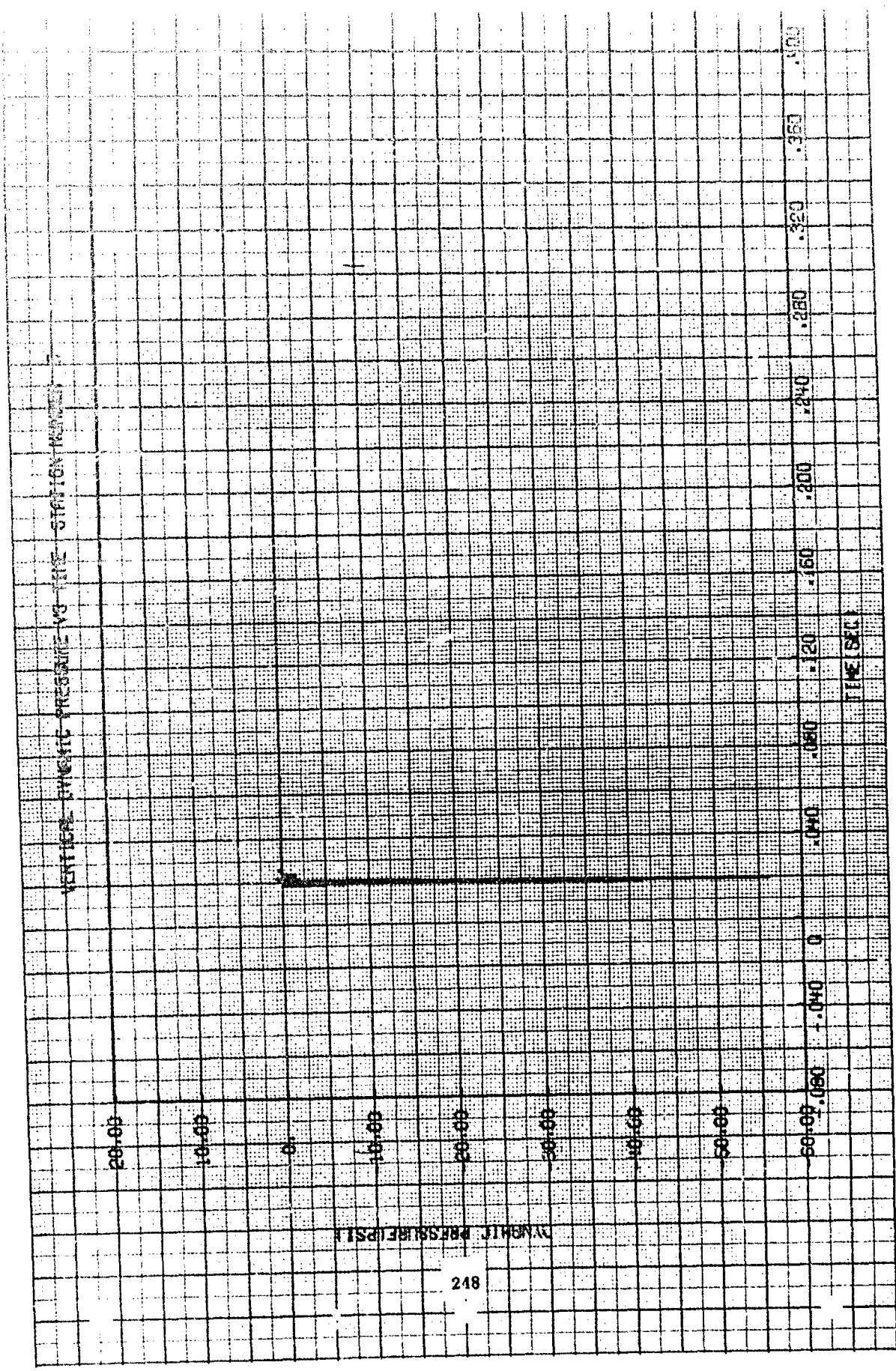
20.00
10.00
0
10.00
20.00
30.00
40.00
50.00

DYNAMIC PRESSURE (PSI)

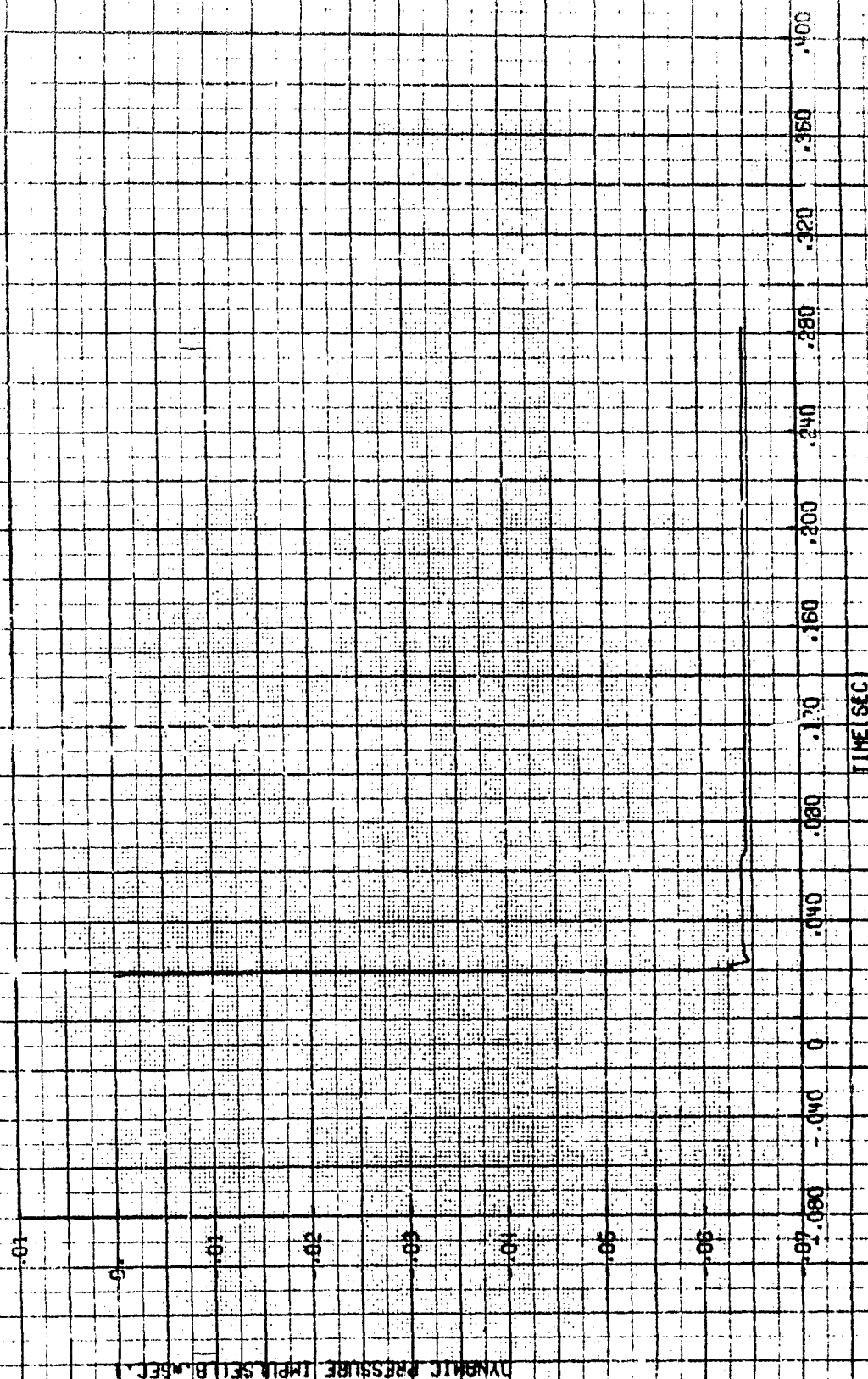
248

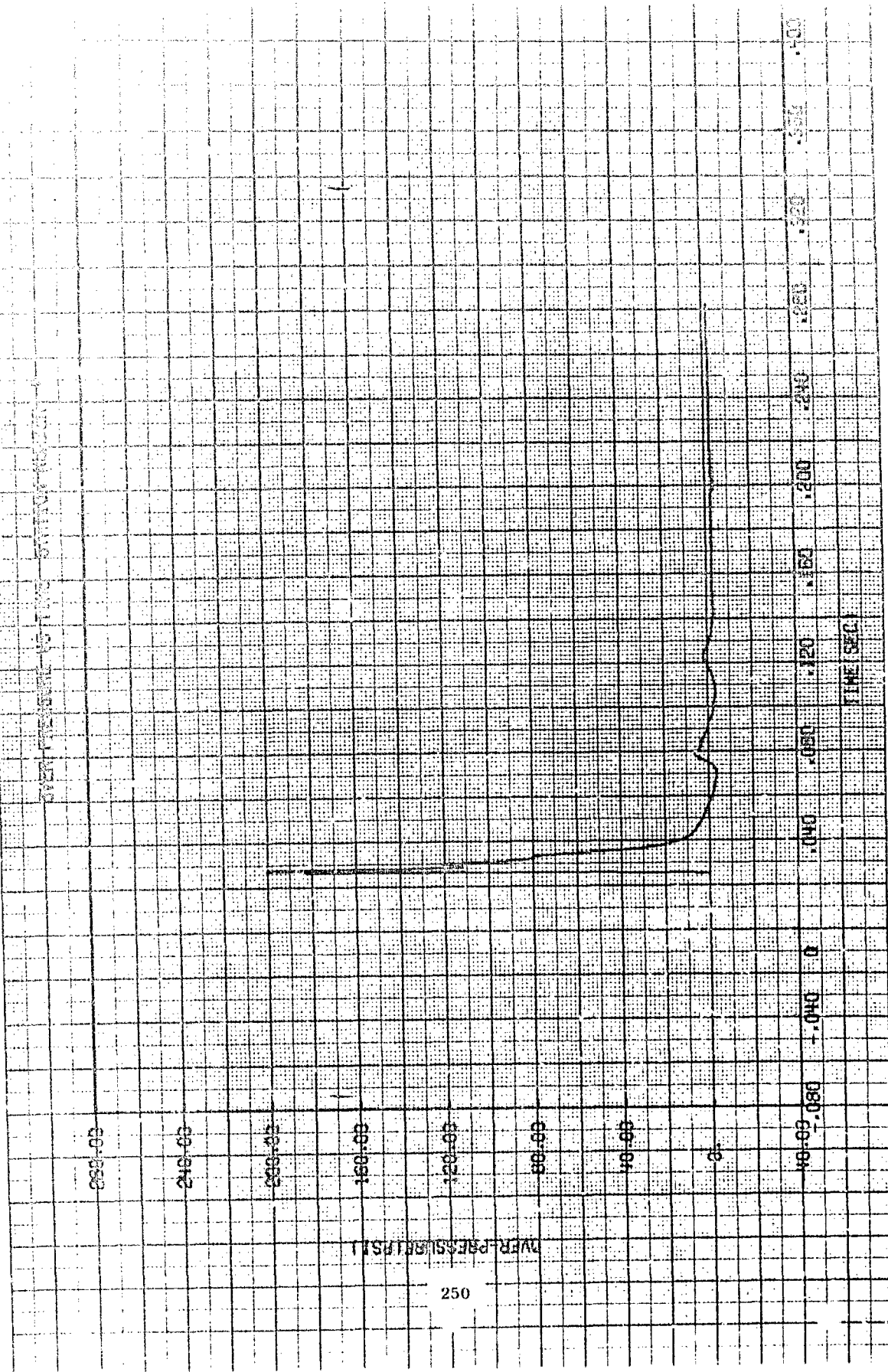
0.000 0.040 0.080 0.120 0.160 0.200 0.240 0.280 0.320 0.360 0.400

TIME (SEC)

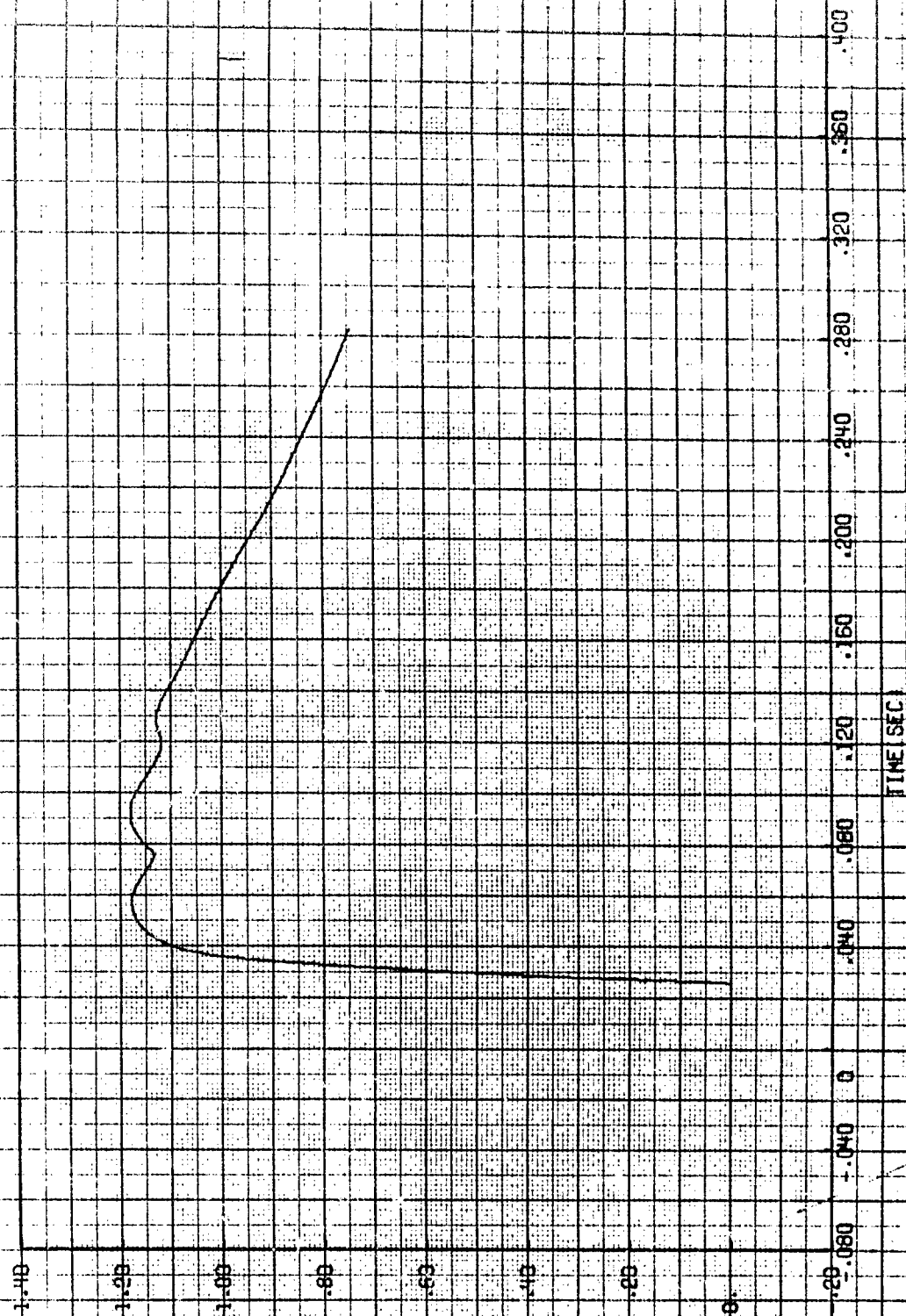


VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 3

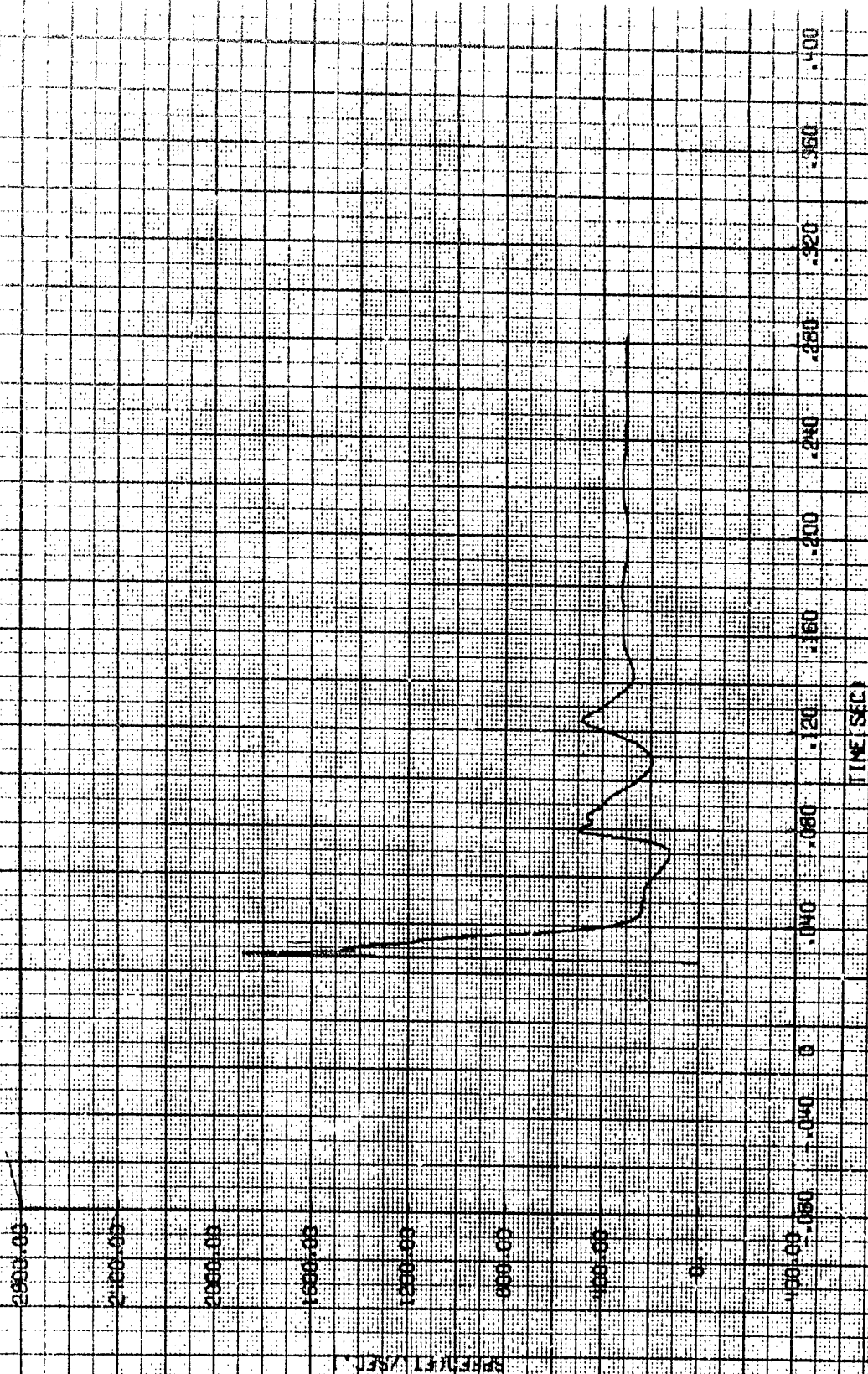




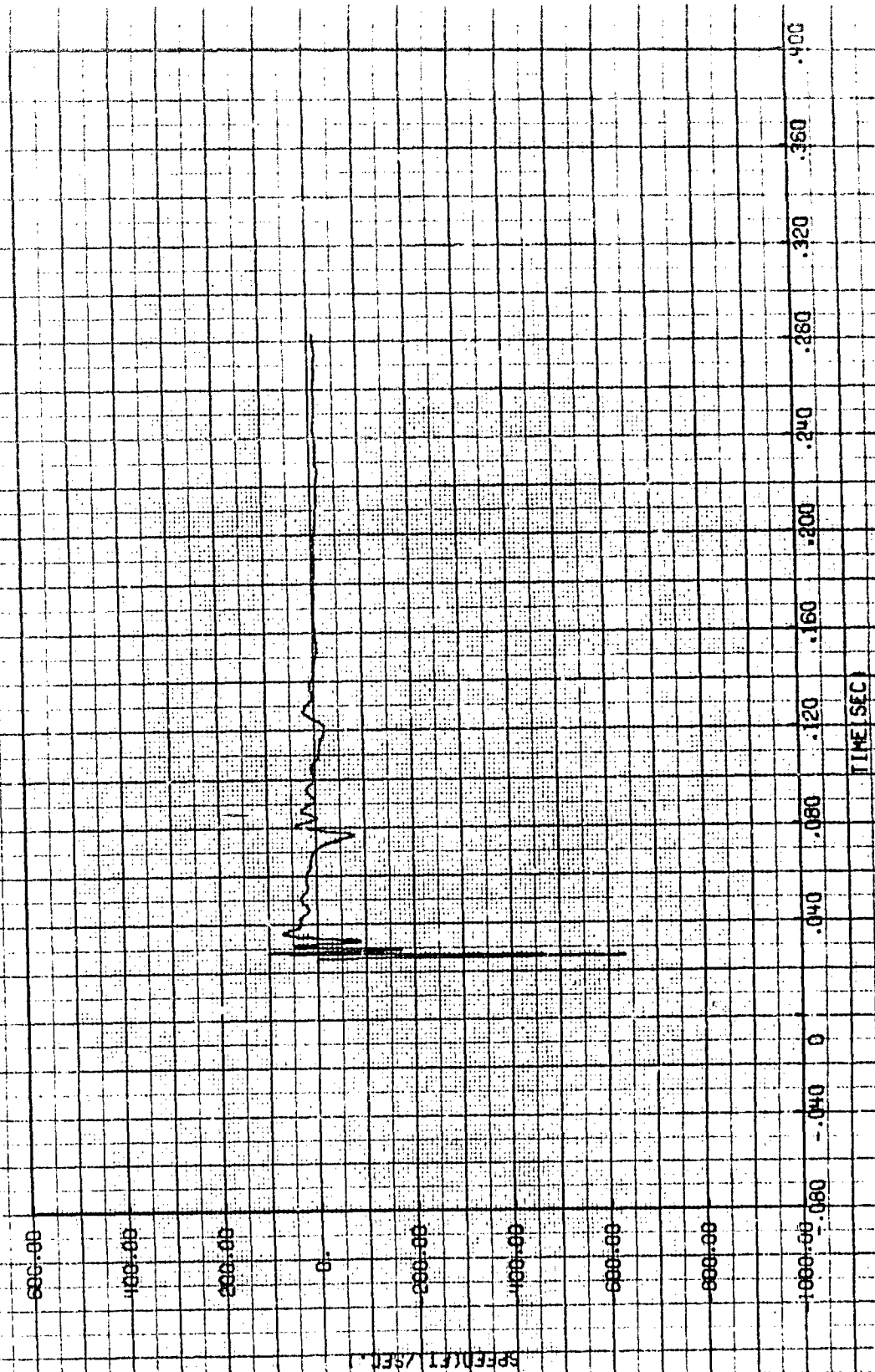
OVER PRESSURE IMPULSE VS TIME STATION NUMBER 4



HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 4



VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 4



HORIZONTAL DYNAMIC PRESSURE VS TIME - STATION NUMBER

280.00

240.00

200.00

160.00

120.00

80.00

40.00

0

DYNAMIC PRESSURE (PSI)

0.00

0.050

0.100

0.150

0.200

0.250

0.300

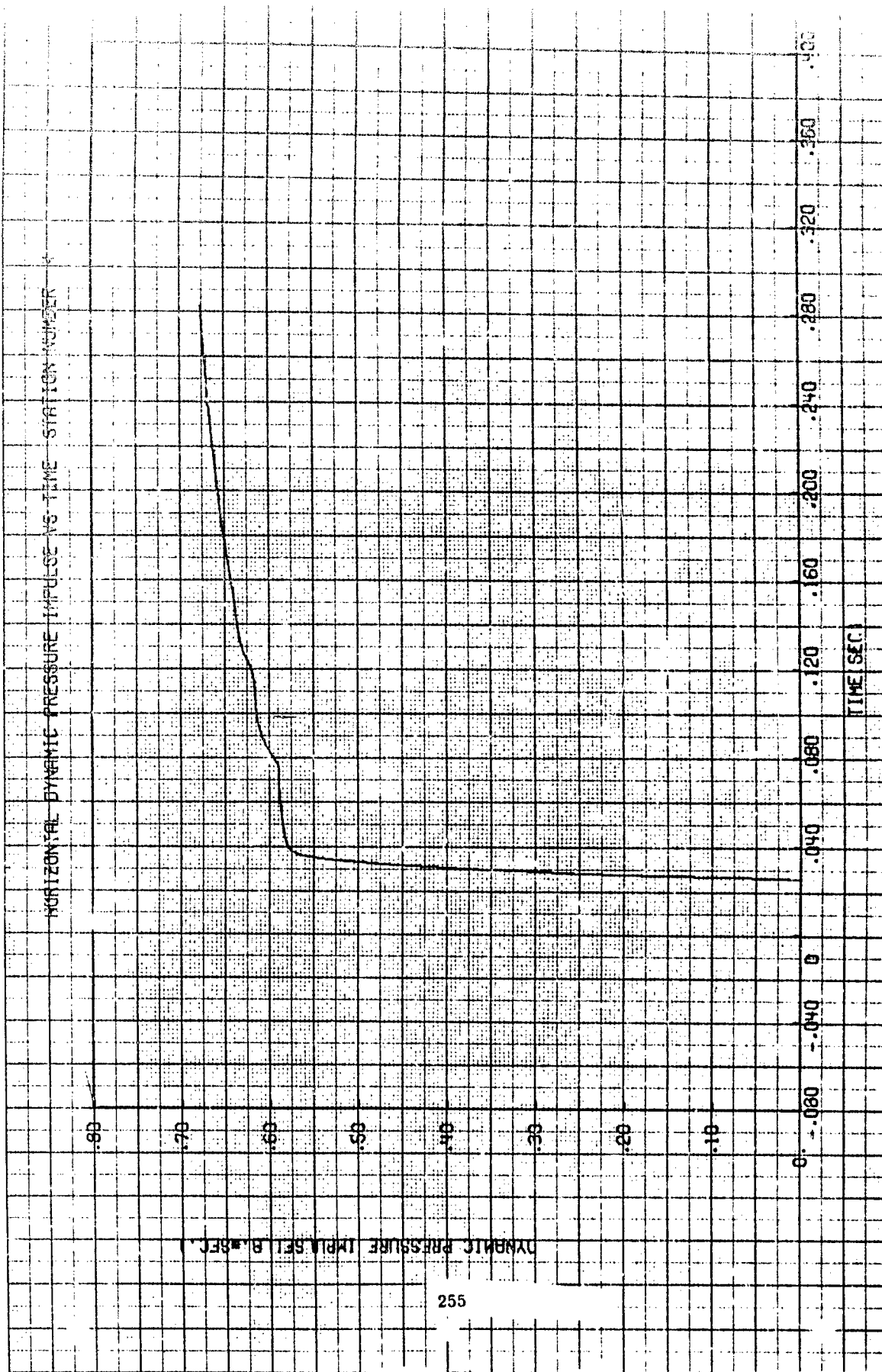
0.350

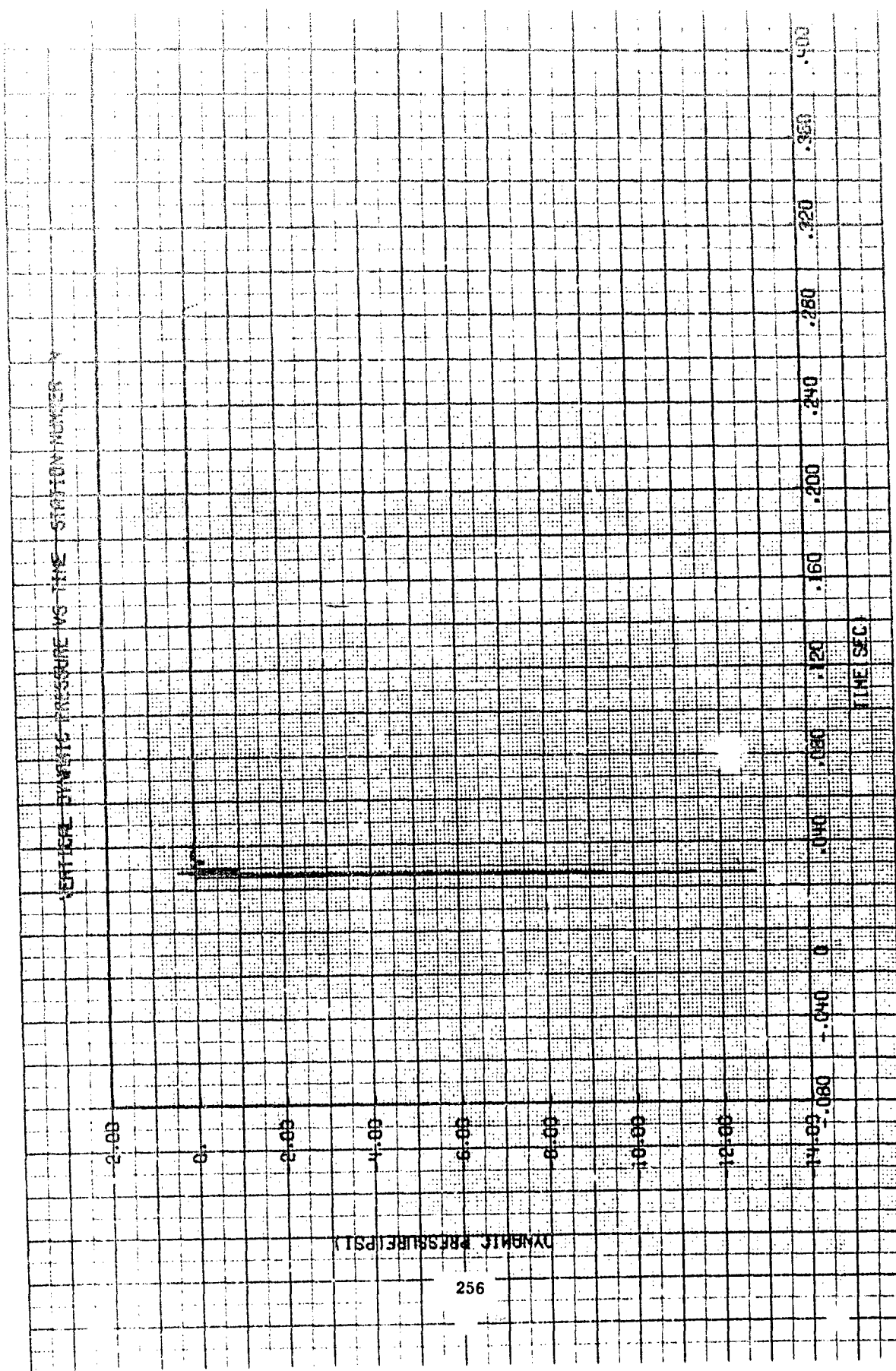
0.400

0.450

0.500

TIME (SEC)





VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 4

0.001000

0.000200

0.000000

0.000000

0.000000

0.000000

0.000000

0.000000

0.400

0.360

0.320

0.280

0.240

0.200

0.160

0.120

0.080

0.040

0

0.000

TIME SEC

DYNAMIC PRESSURE IMPULSE LBS/SEC

OVER PRESSURE VS TIME STATION NUMBER 5

120.00

100.00

80.00

60.00

40.00

20.00

0

-20.00

-40.00

-60.00

OVER PRESSURE (PSI)

258

0.400

0.350

0.300

0.250

0.200

0.150

0.100

0.050

0.000

-0.050

-0.100

-0.150

-0.200

-0.250

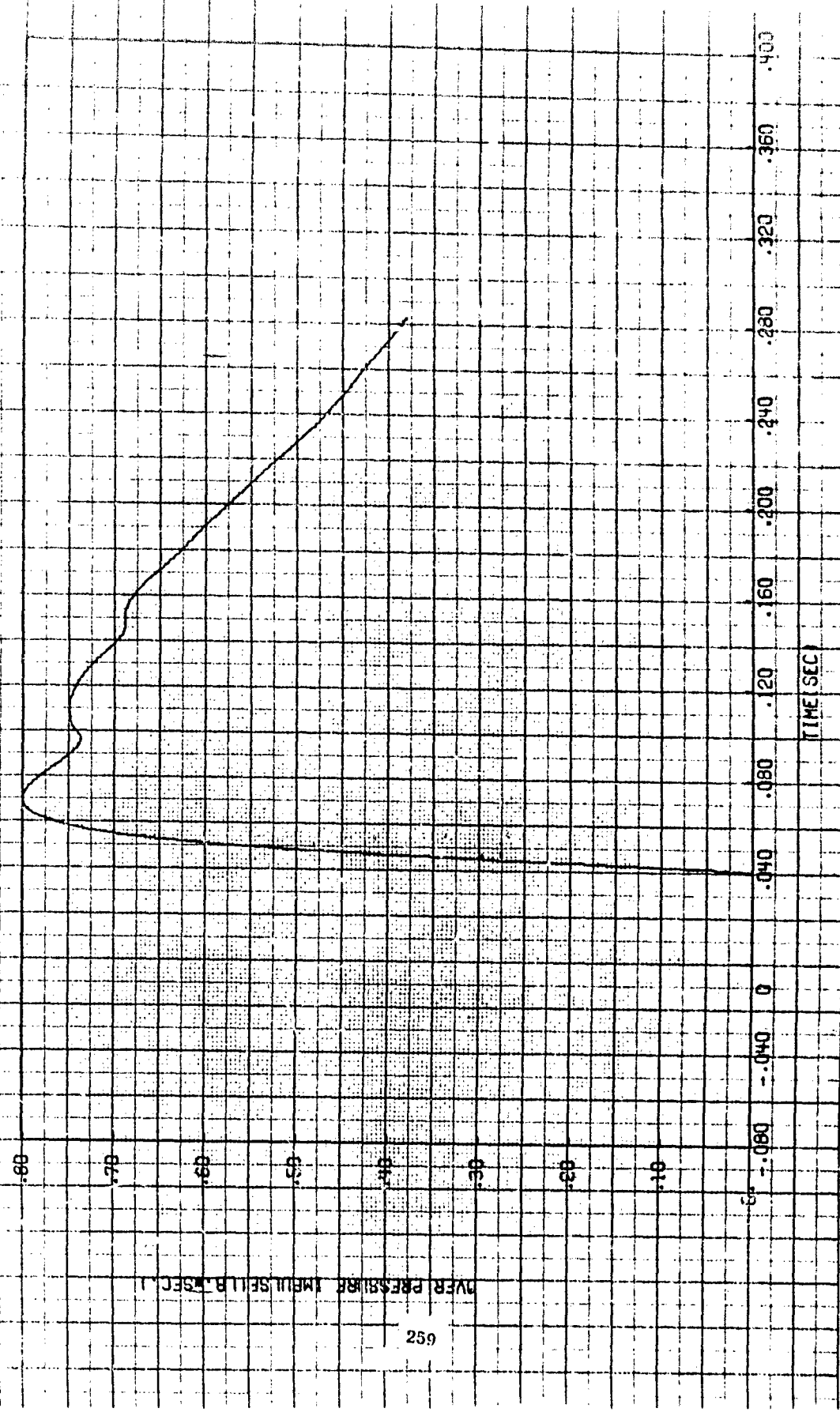
-0.300

-0.350

-0.400

TIME (SEC)

OVER PRESSURE IMPULSE VS TIME - STATION NUMBER 5



OVER PRESSURE IMPULSE (LBS./SQ. IN. SEC.)

TIME (SEC.)

HORIZONTAL CURRENT VELOCITY VS TIME - WIDE

2600.00

2400.00

2200.00

2000.00

1800.00

1600.00

1400.00

1200.00

1000.00

800.00

600.00

400.00

SPEED (FT/SEC)

260

0

0.040

0

0.080

0.120

0.160

0.200

0.240

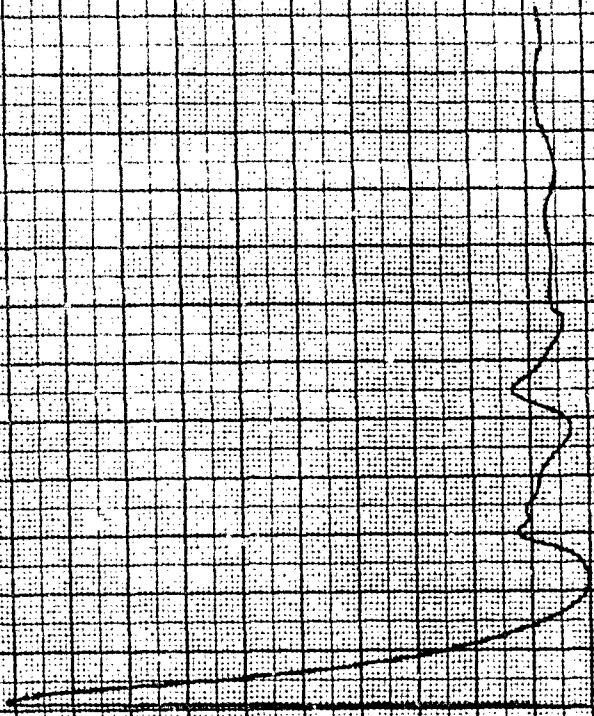
0.280

0.320

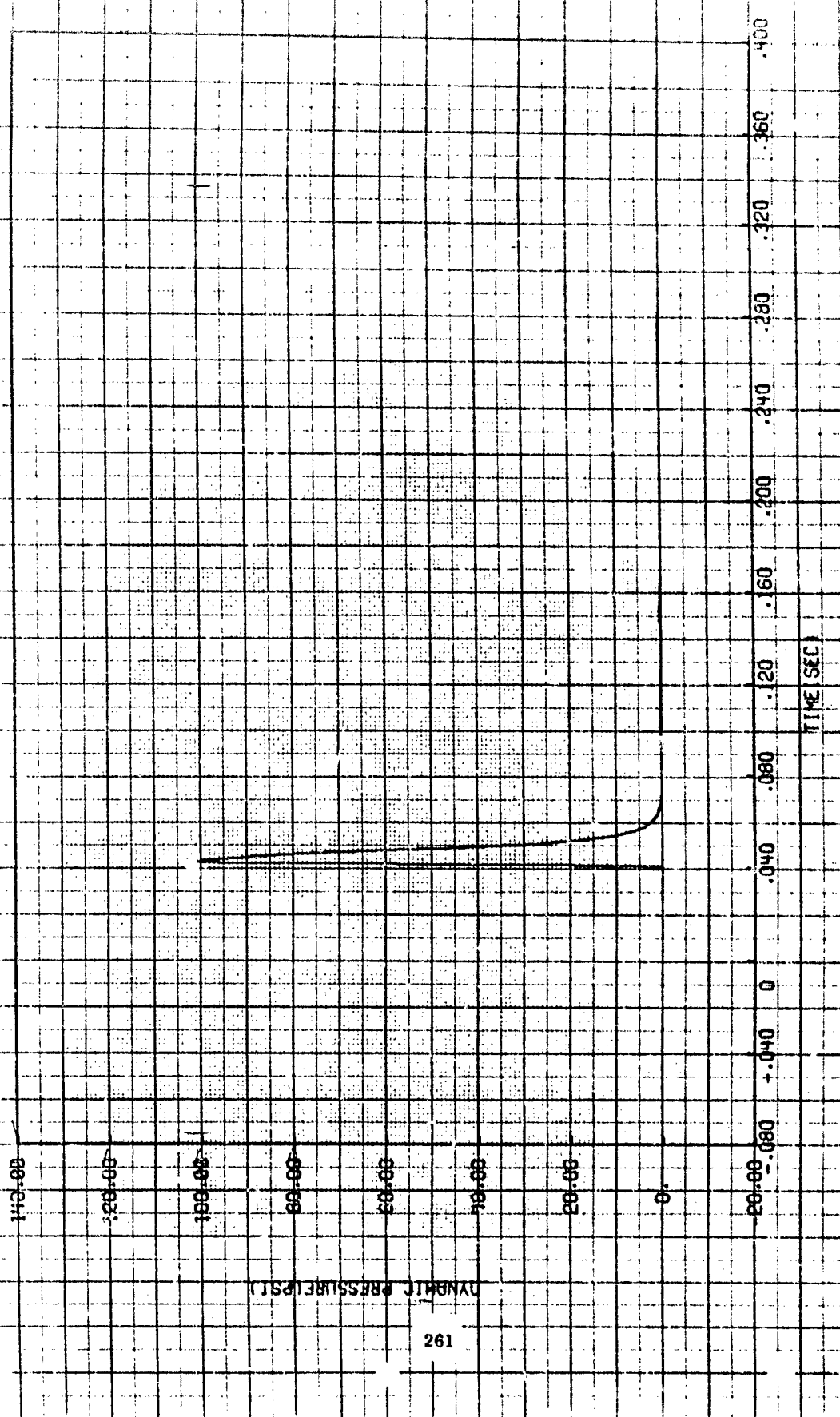
0.360

0.400

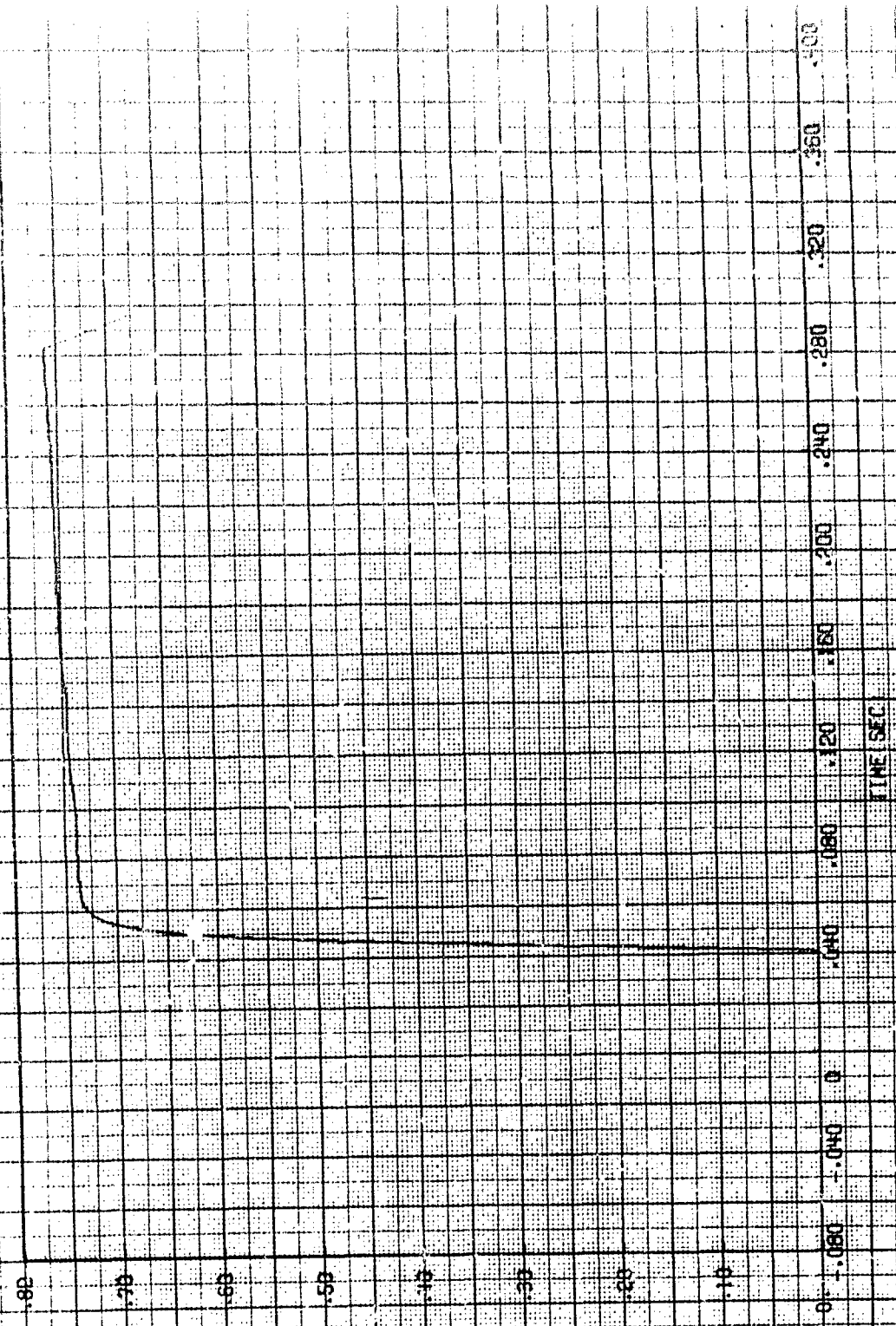
TIME (SEC)

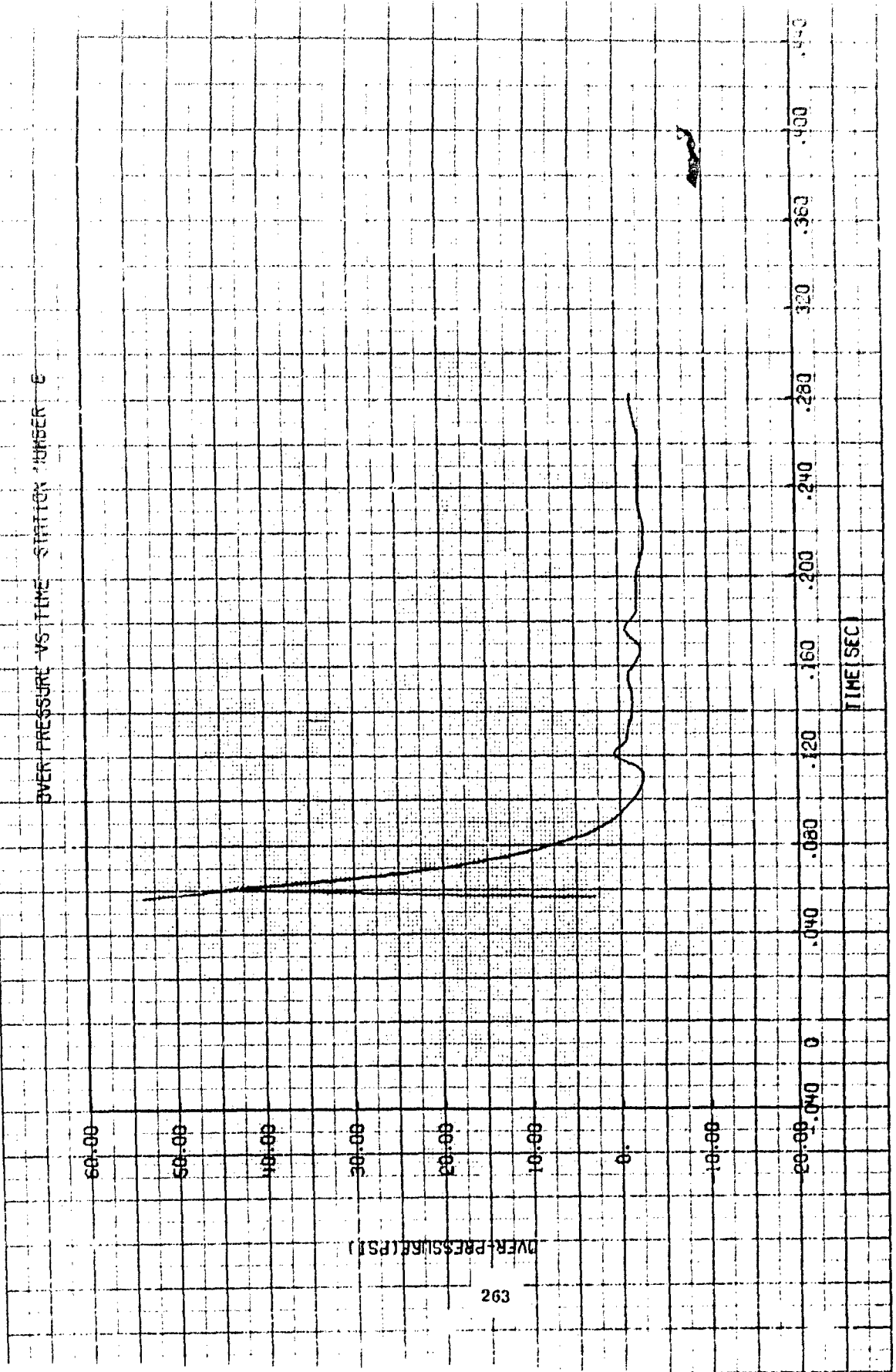


HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 5



HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 5

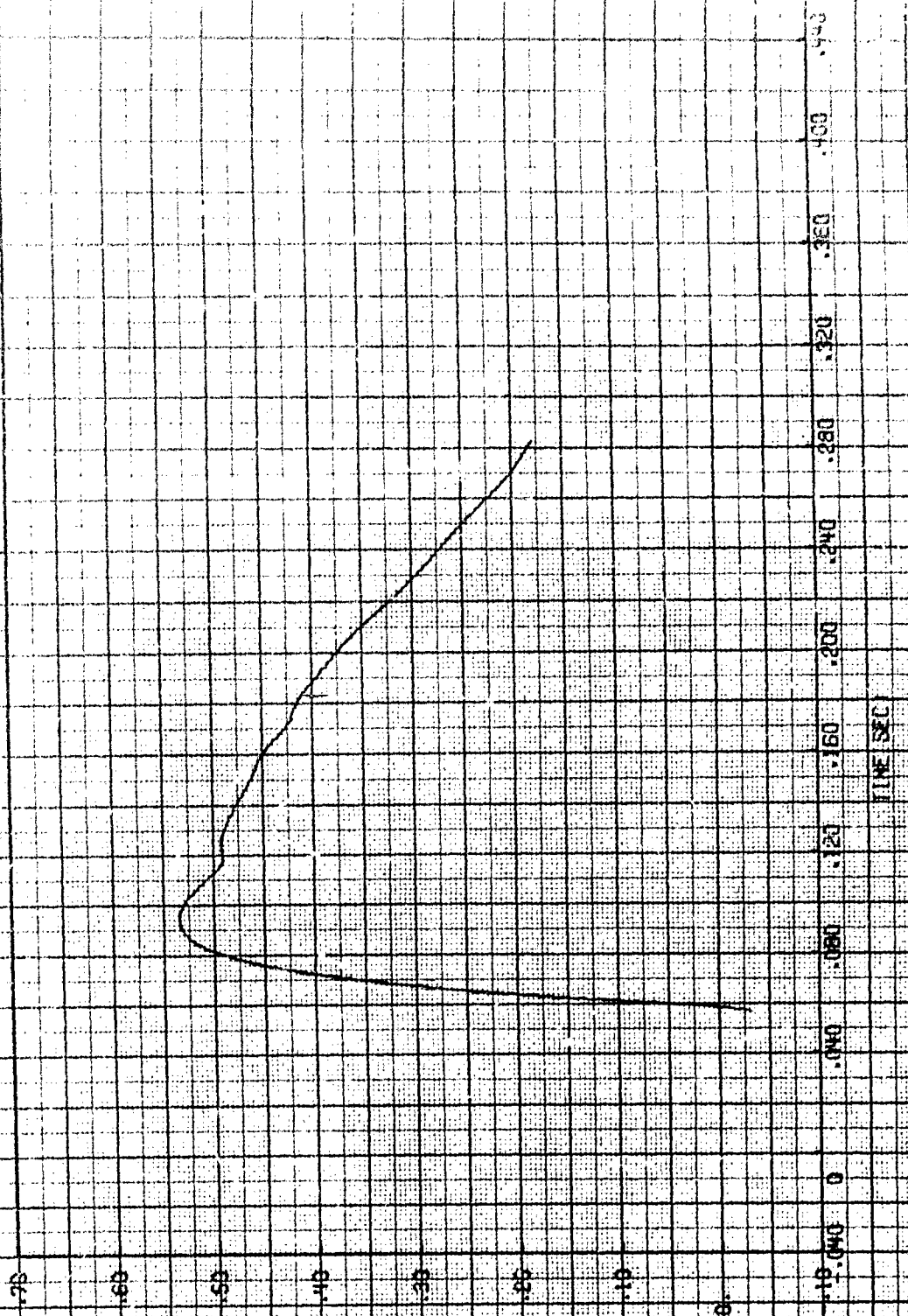




OVER PRESSURE (PSI)

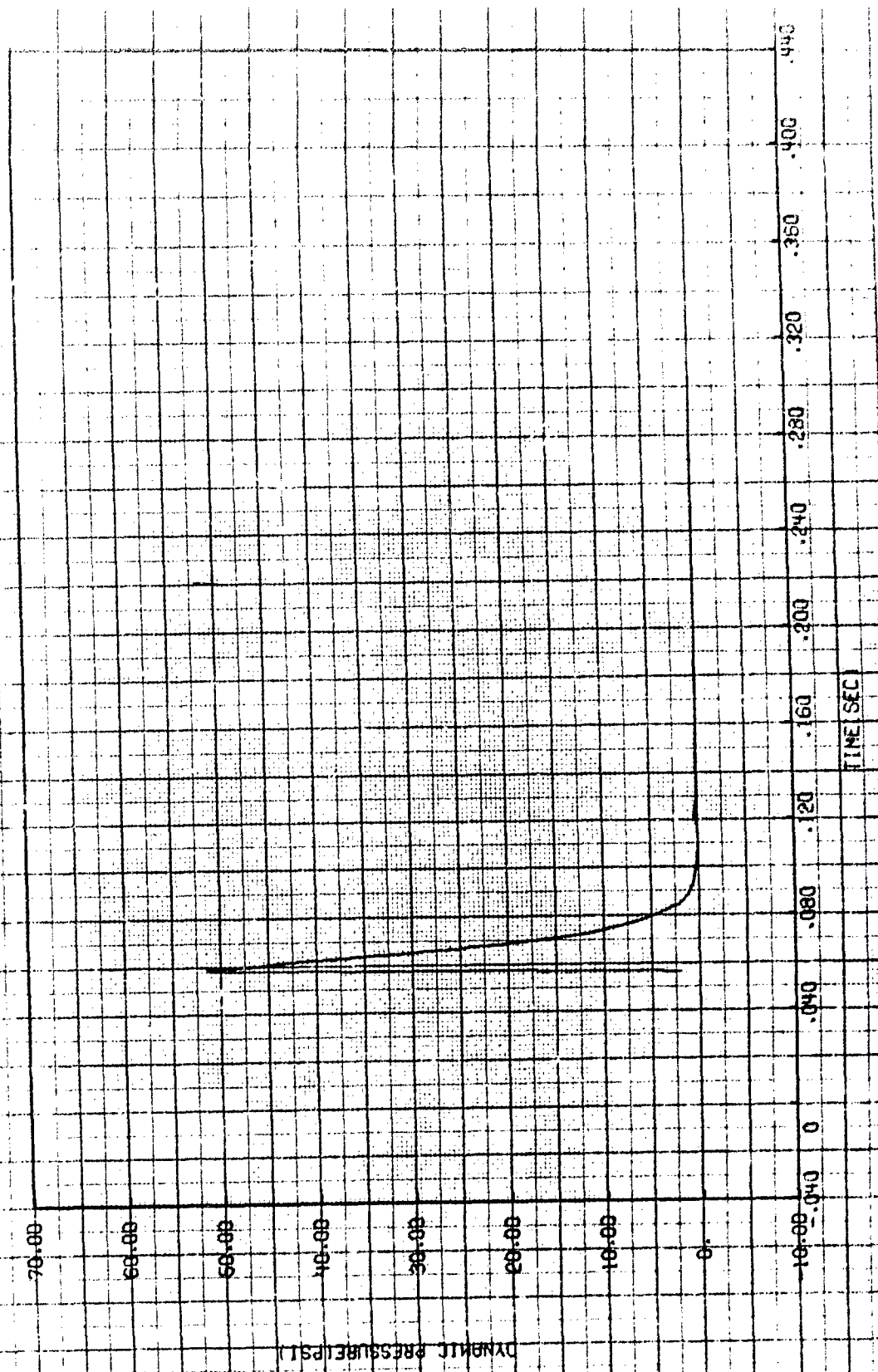
TIME (SEC)

OVER PRESSURE IMPULSE VS TIME STATION NUMBER 6



OVER PRESSURE IMPULSE (LBS./SQ. IN.)

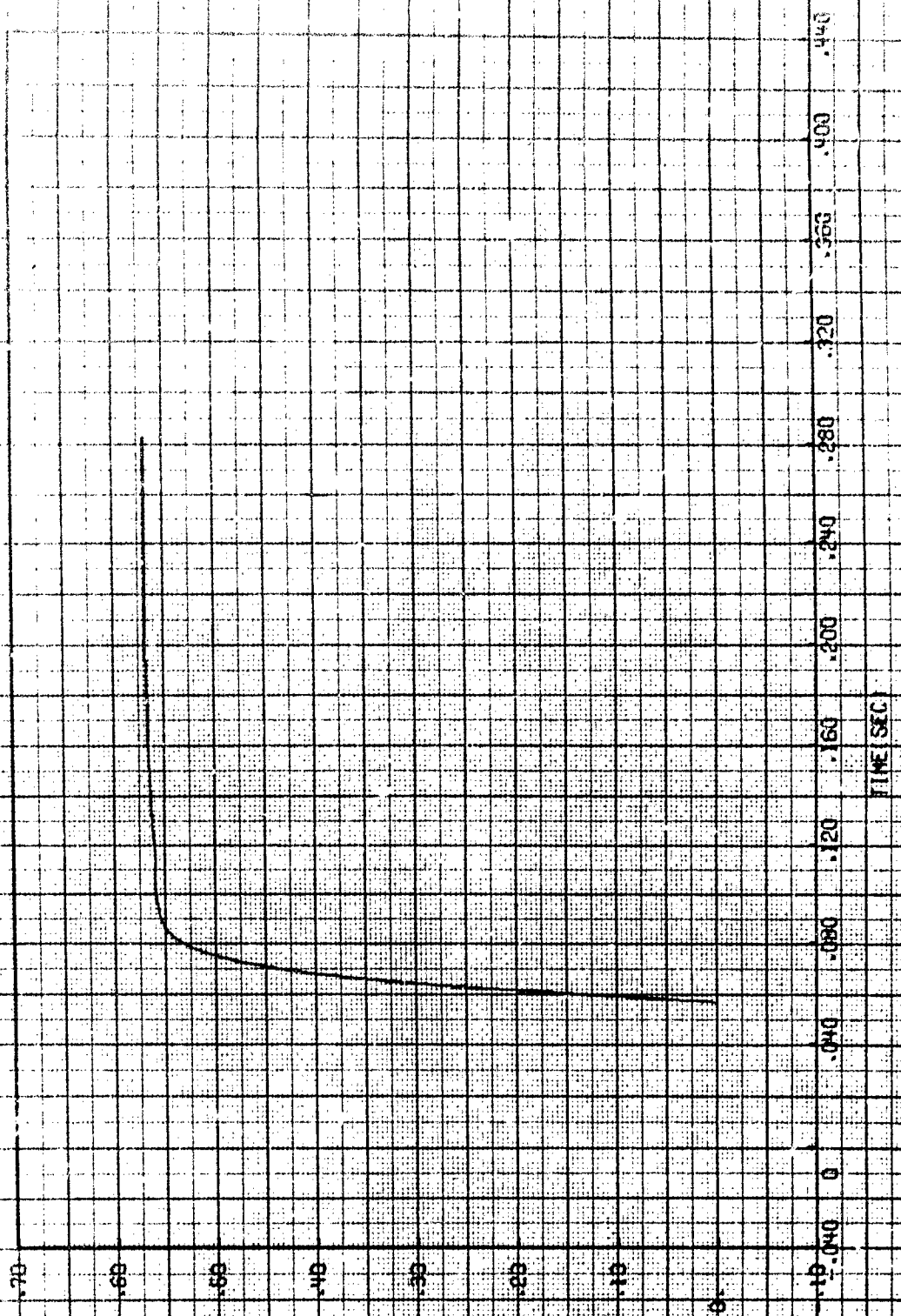
HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 6



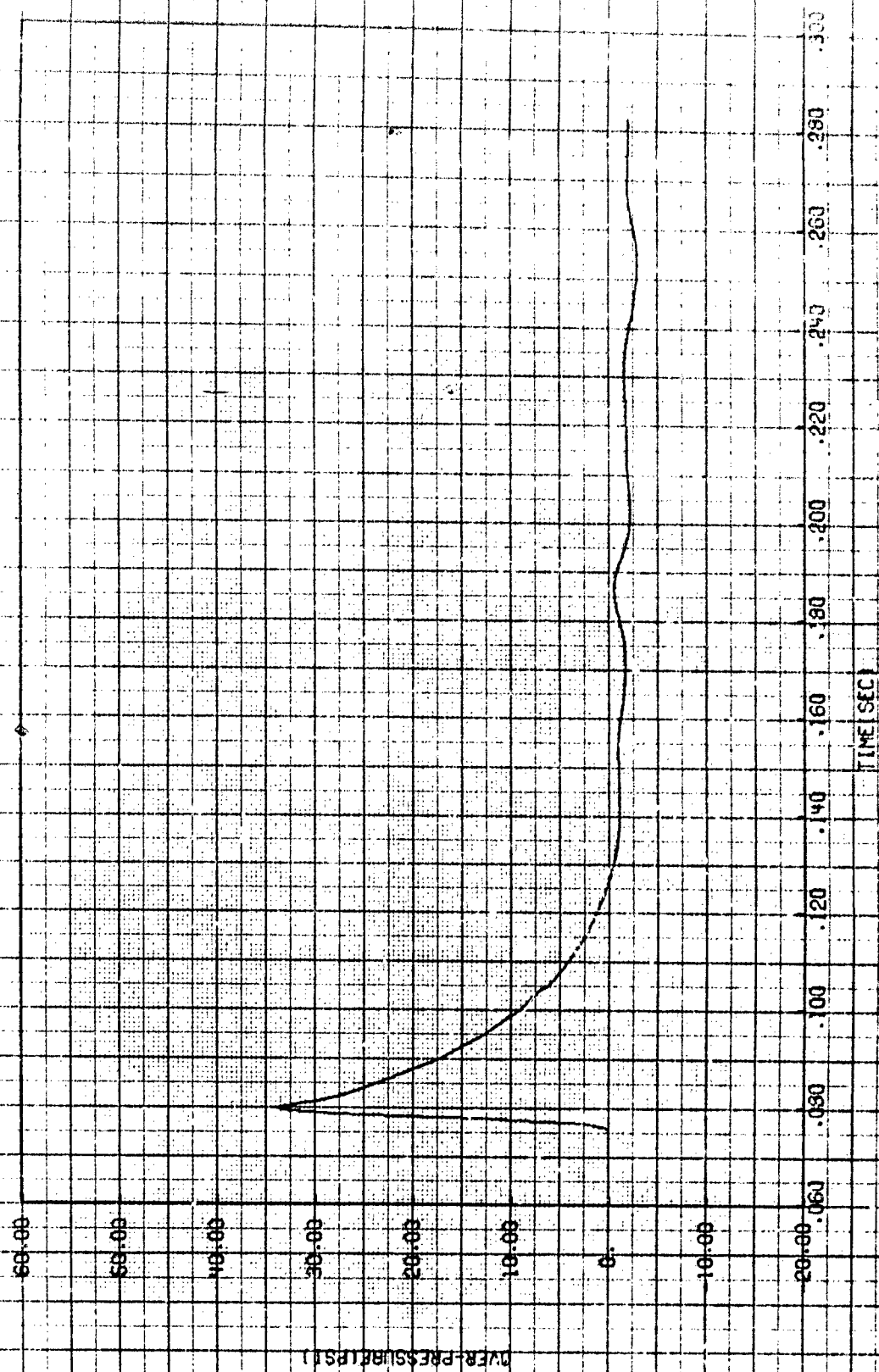
DYNAMIC PRESSURE (PSI)

TIME (SEC)

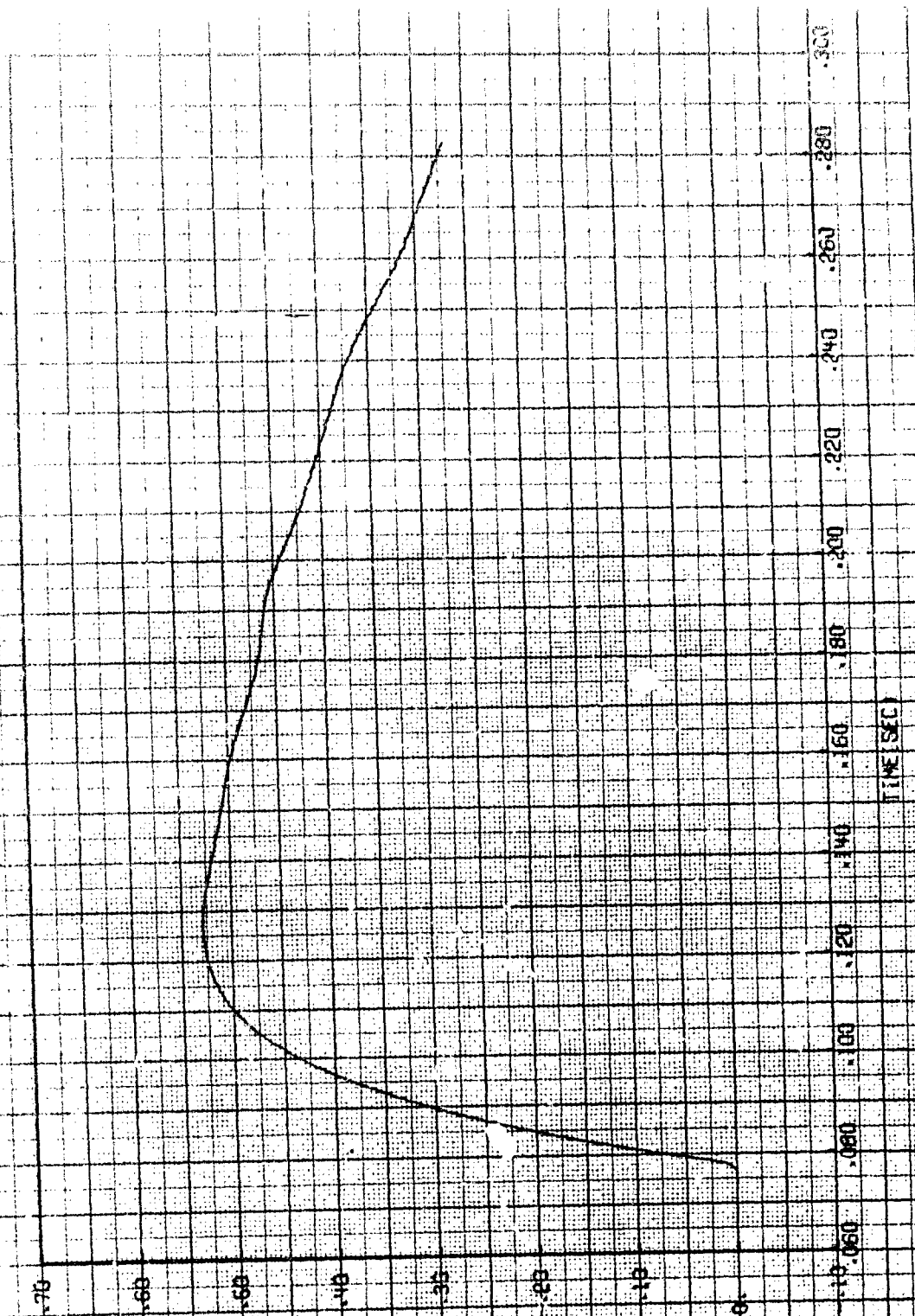
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 6



OVER PRESSURE VS TIME STATION NUMBER 7

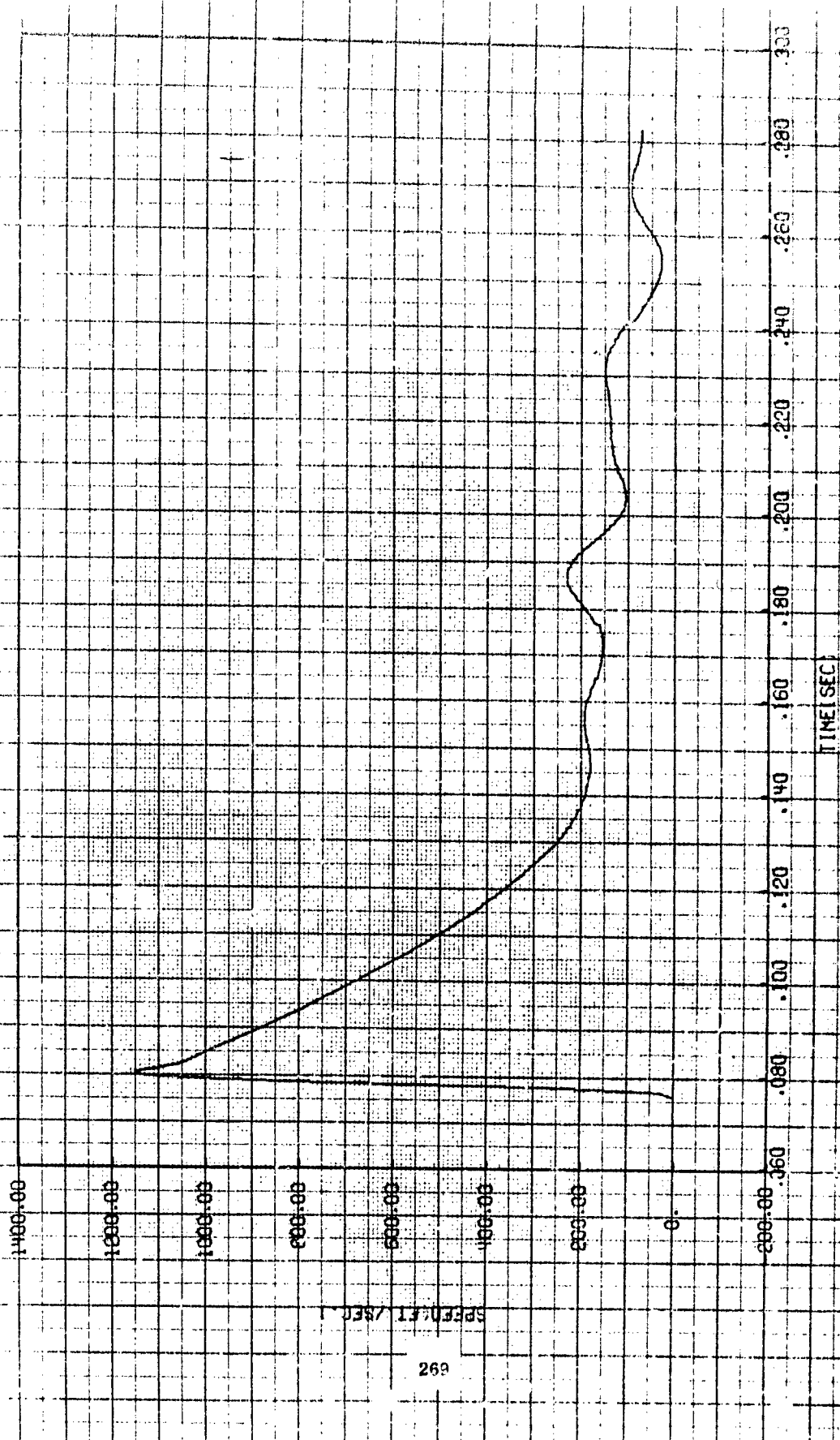


OVER PRESSURE IMPULSE VS TIME STATION NUMBER 7

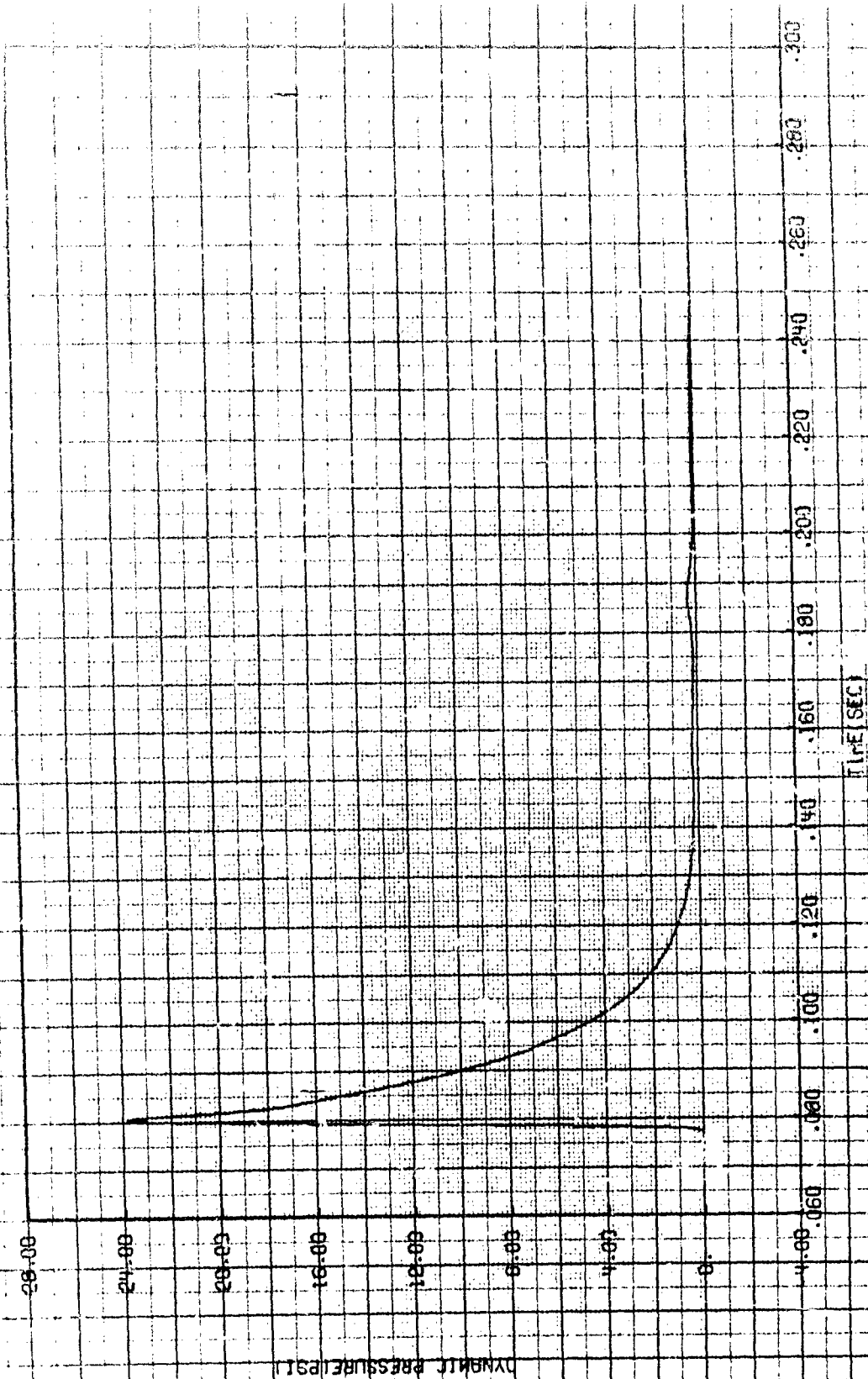


OVER PRESSURE IMPULSE (LB./SQ. IN.-SEC.)

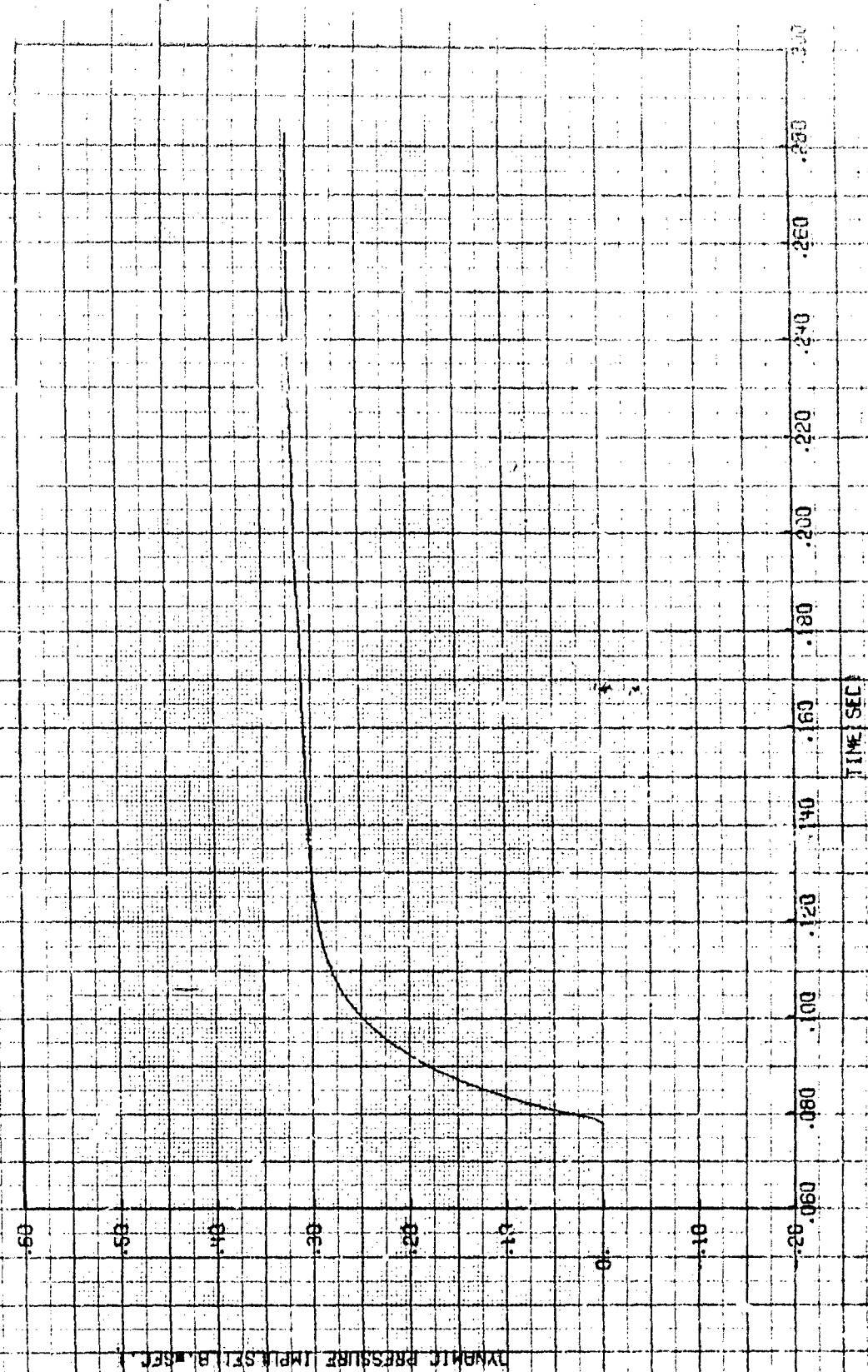
HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 5



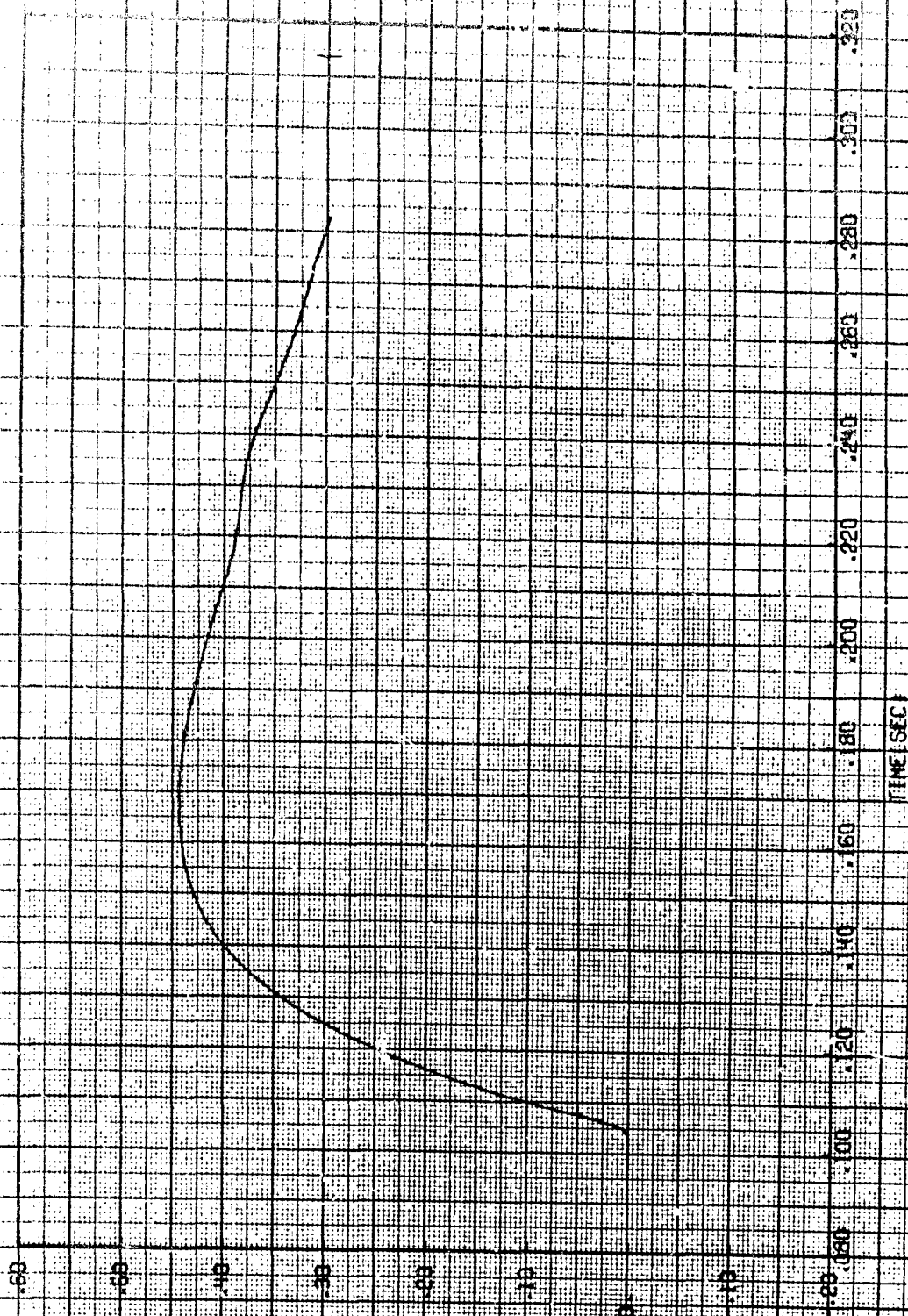
HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 7



HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 7

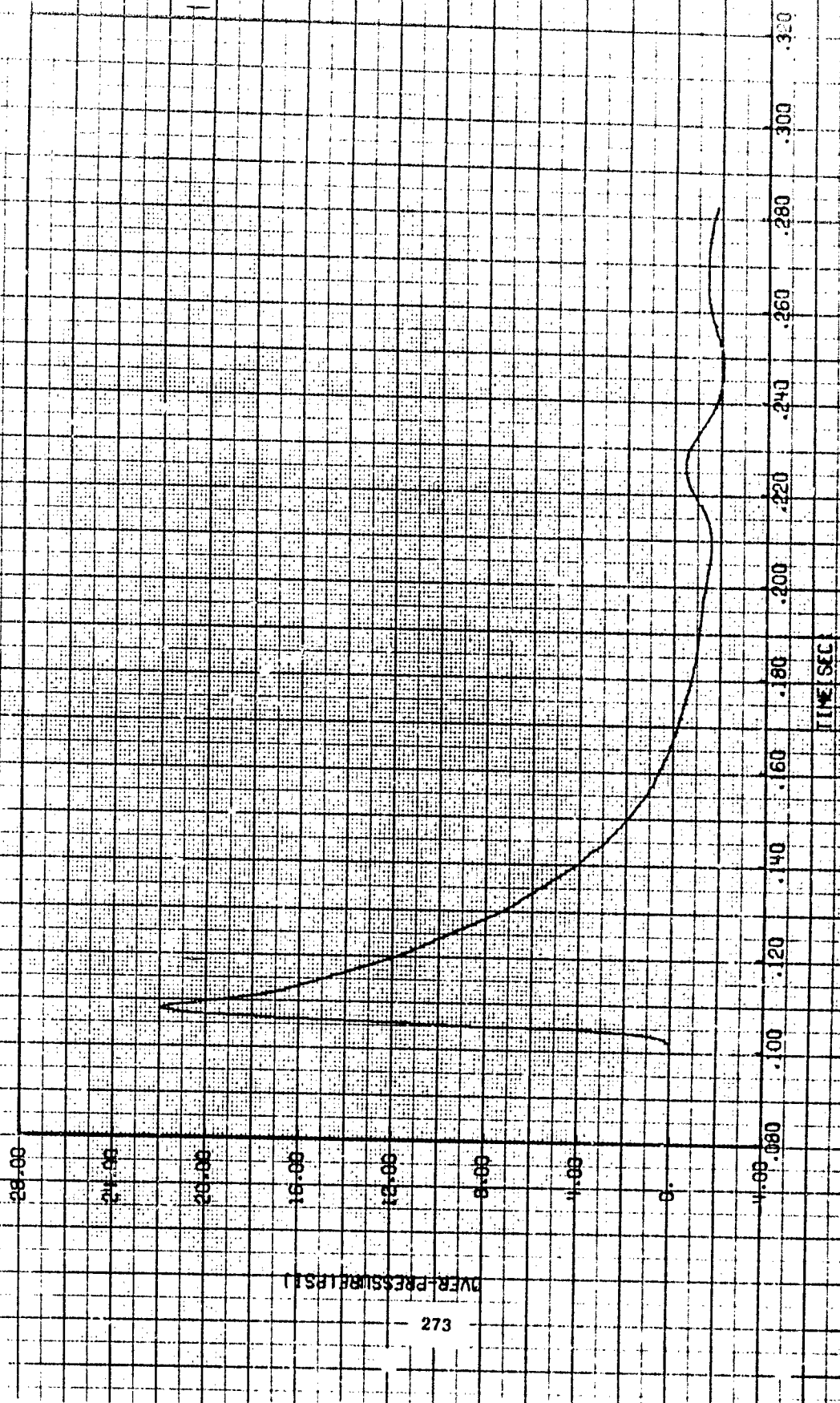


OVER PRESSURE IMPULSE VS TIME - STATION NUMBER 0

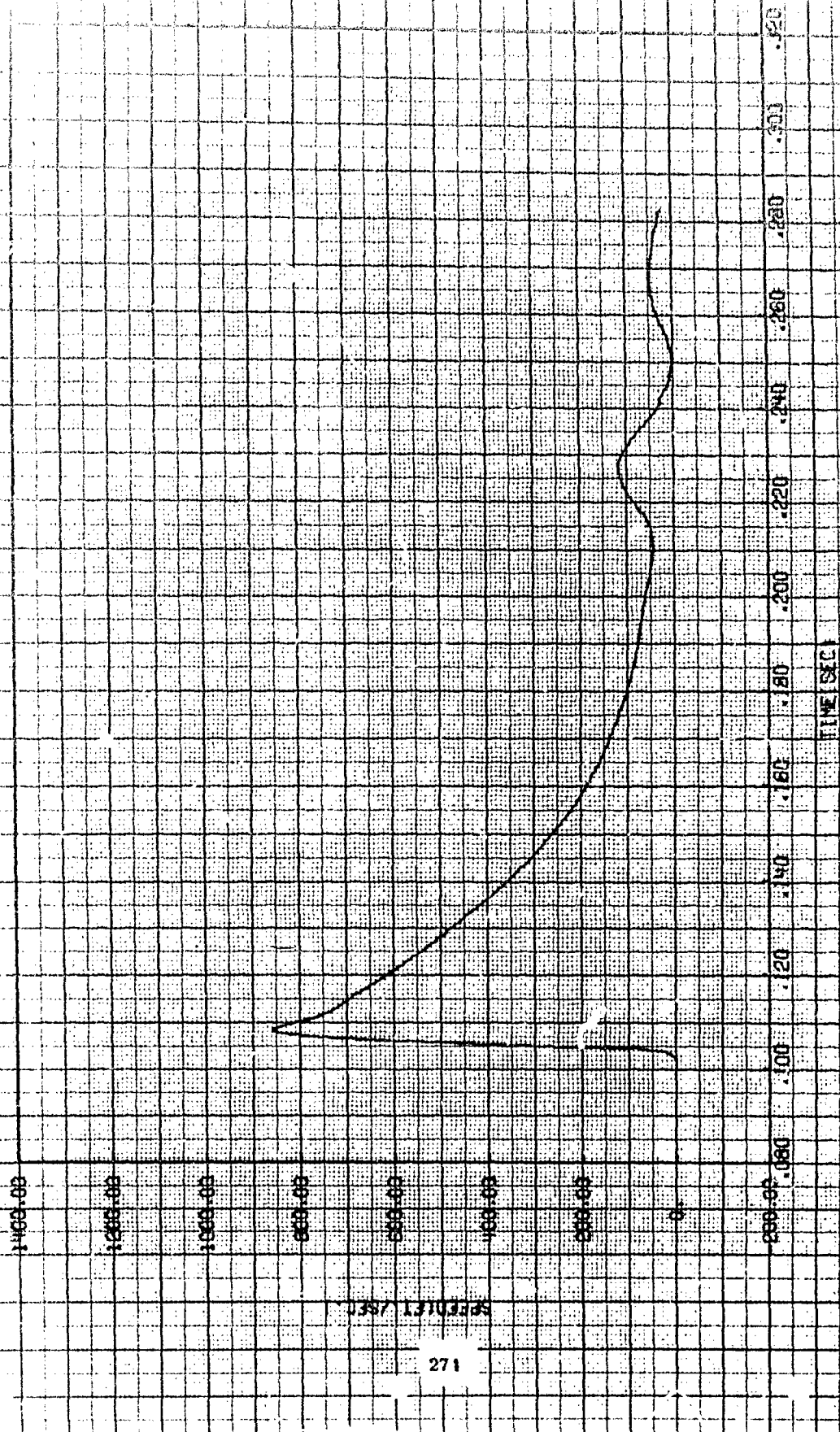


OVER PRESSURE IMPULSE (MEINSELB * SEC)

OVER PRESSURE VS TIME STATION NUMBER 8

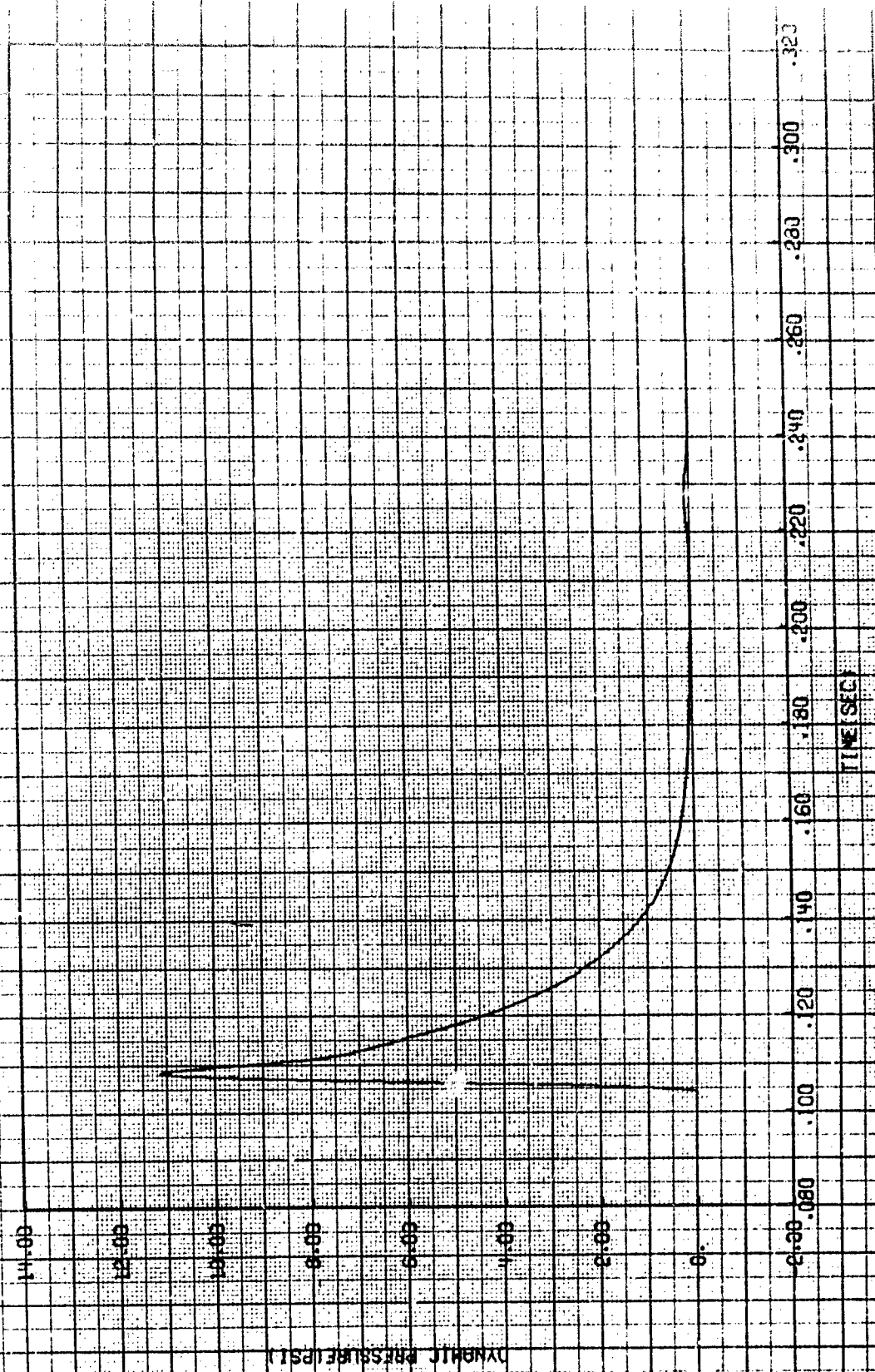


HORIZONTAL COMPONENT VELOCITY VS TIME - STATION NUMBER 3

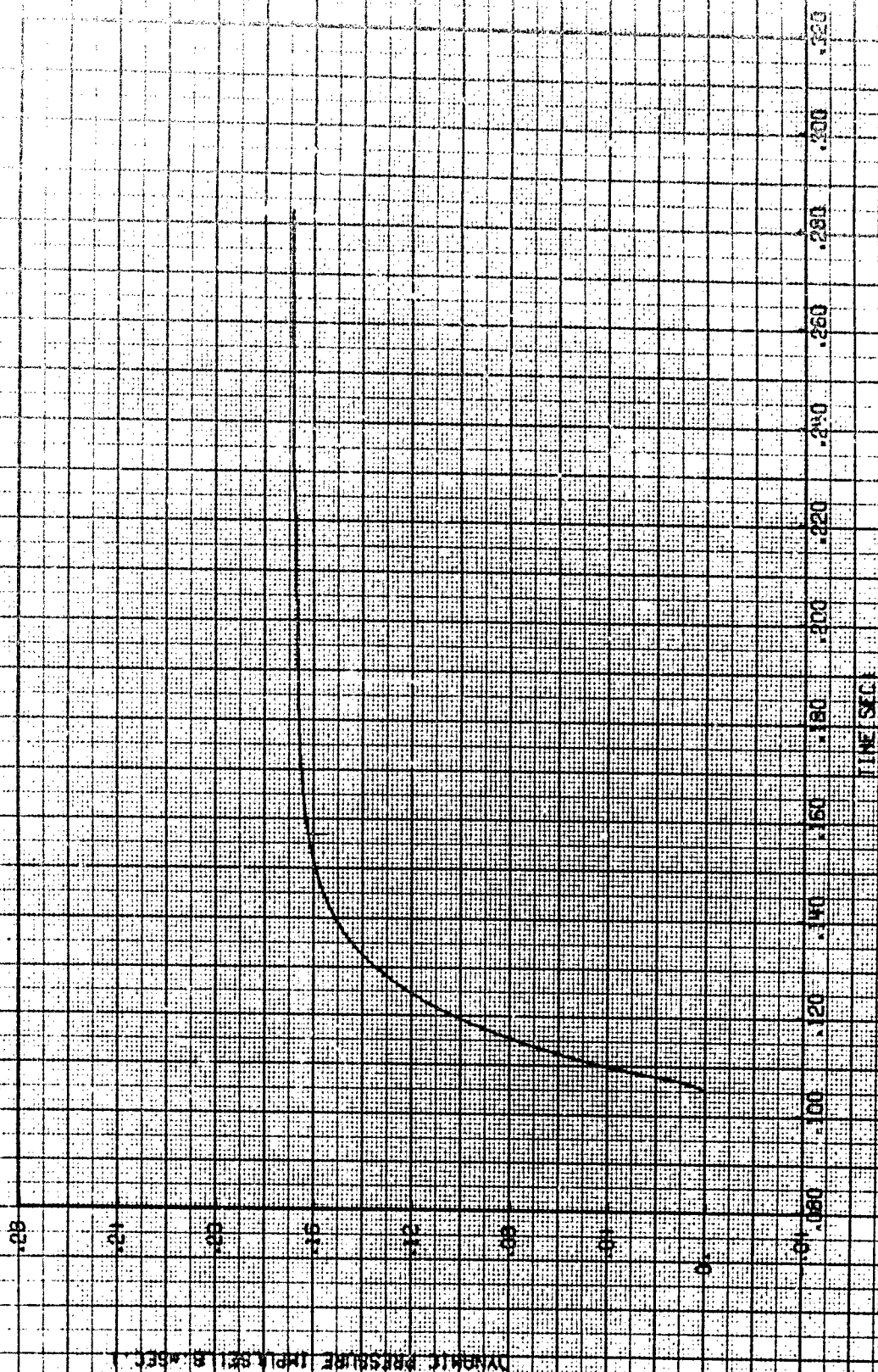


337 1370333

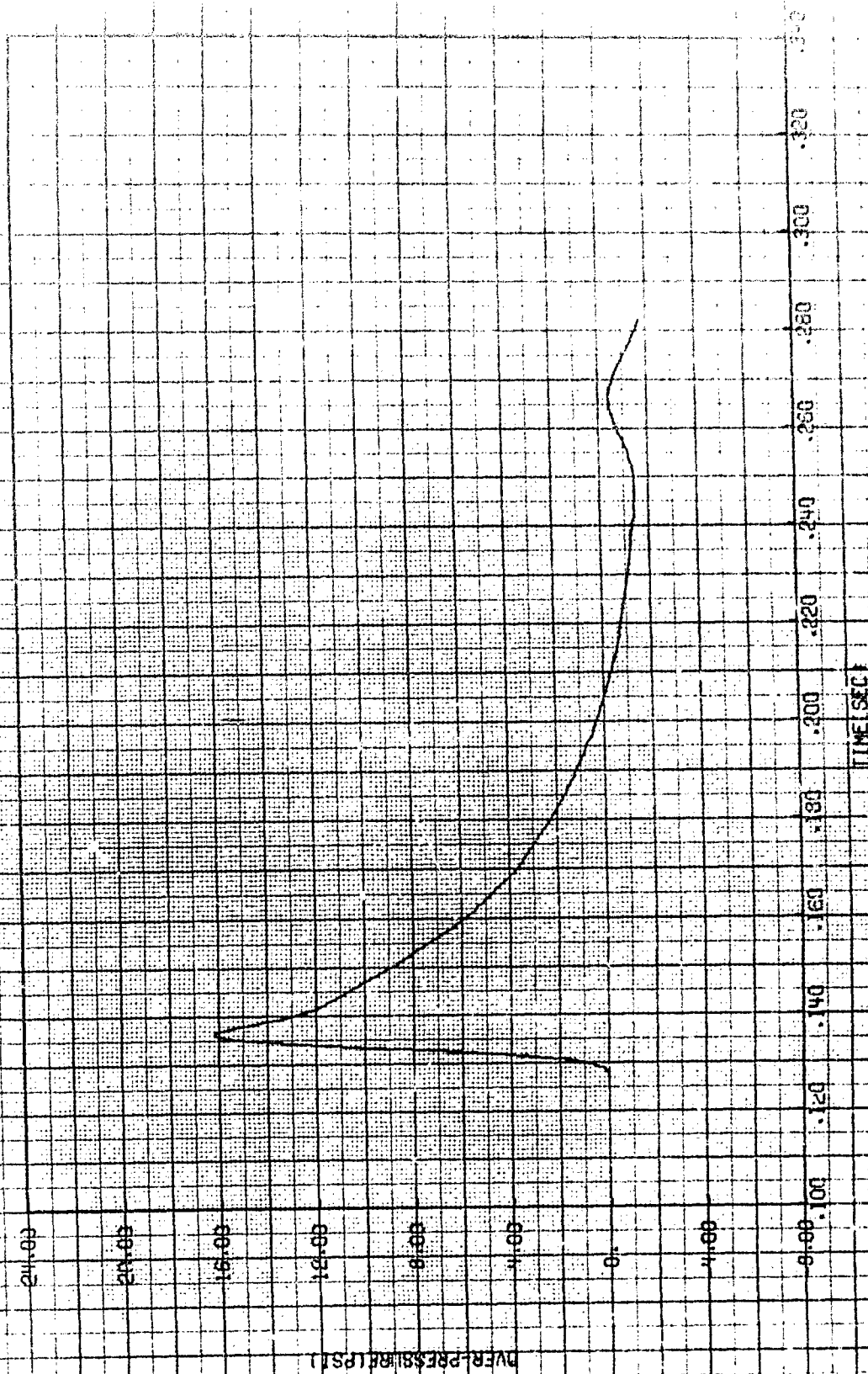
HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 3



HORIZONTAL DYNAMIC PRESSURE INFEET VS TIME STATION NUMBER 2



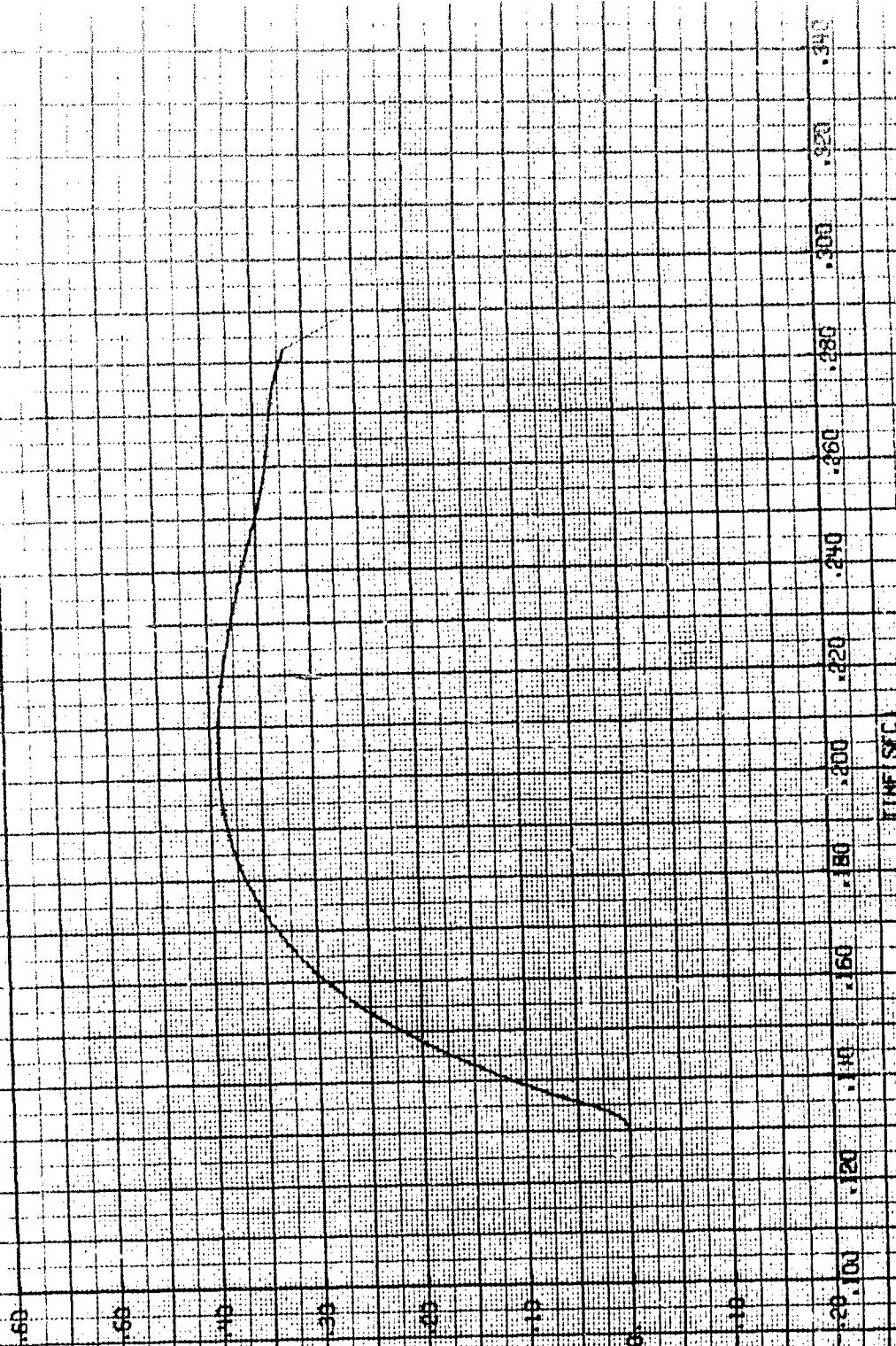
OVER PRESSURE VS TIME STATION NUMBER 5



OVER PRESSURE (PSI)

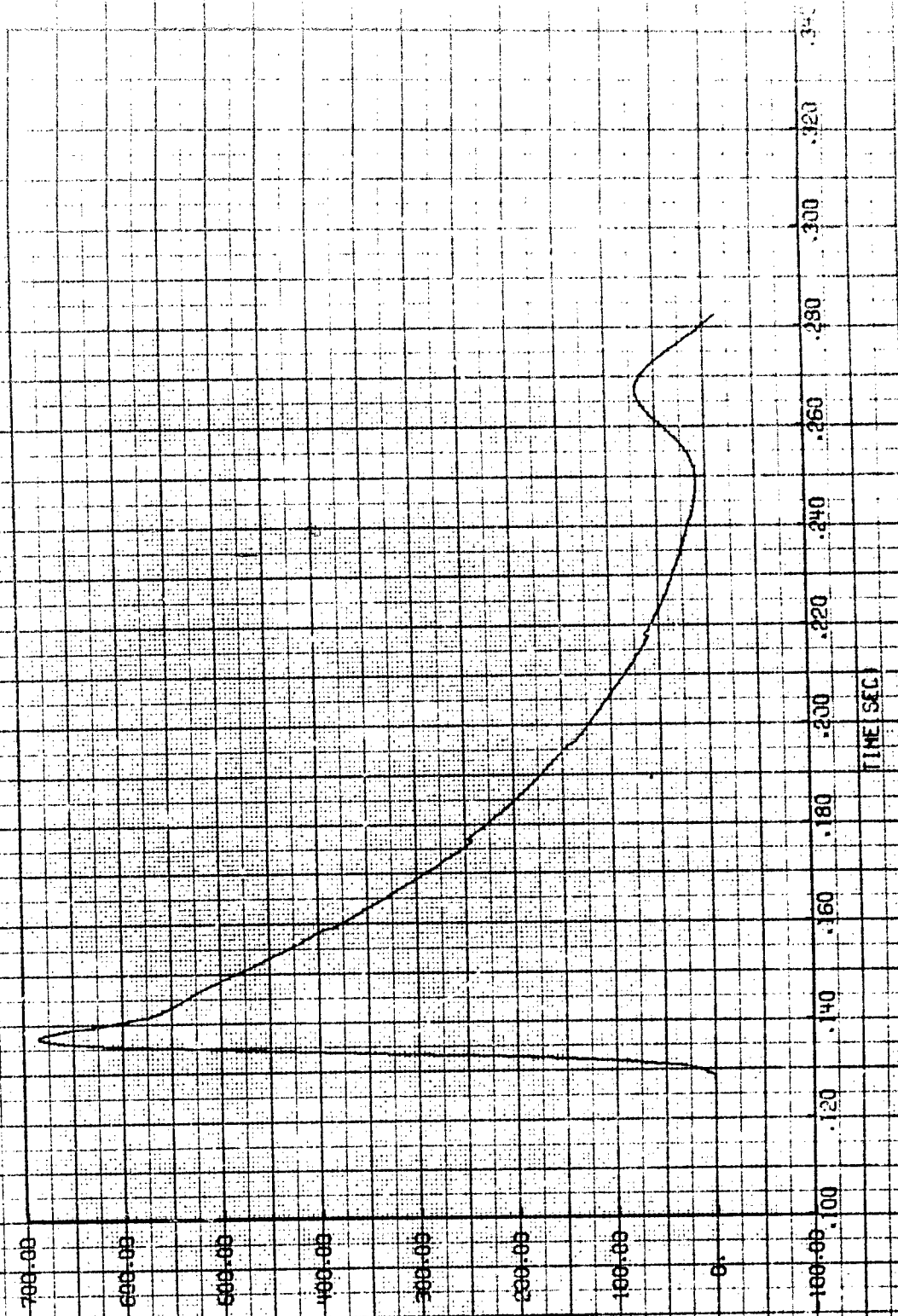
TIME (SEC)

OVER PRESSURE IMPULSE VS TIME, STATION NUMBER 9

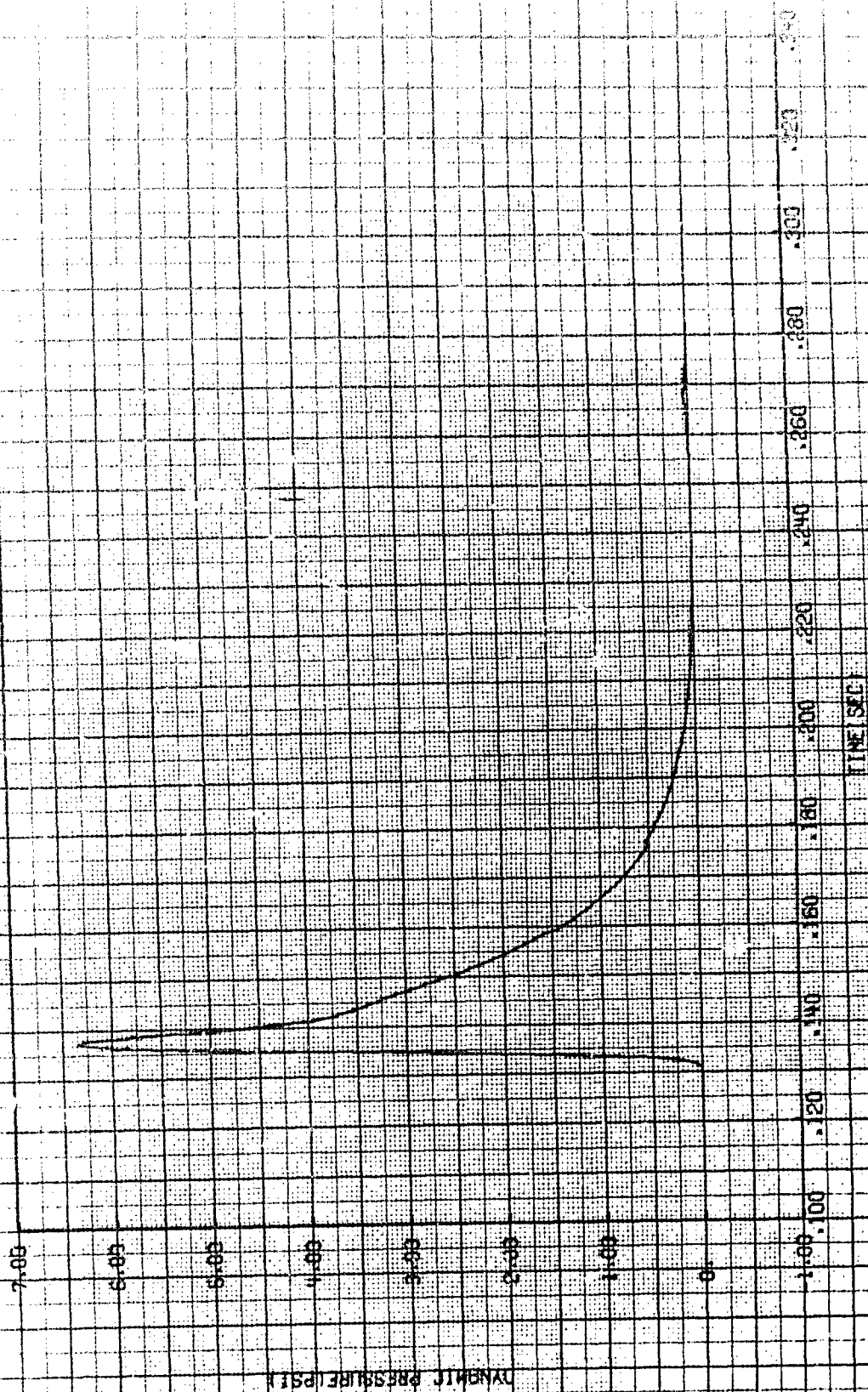


OVER PRESSURE IMPULSE, LBS/IN. SEC. 1

HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 9

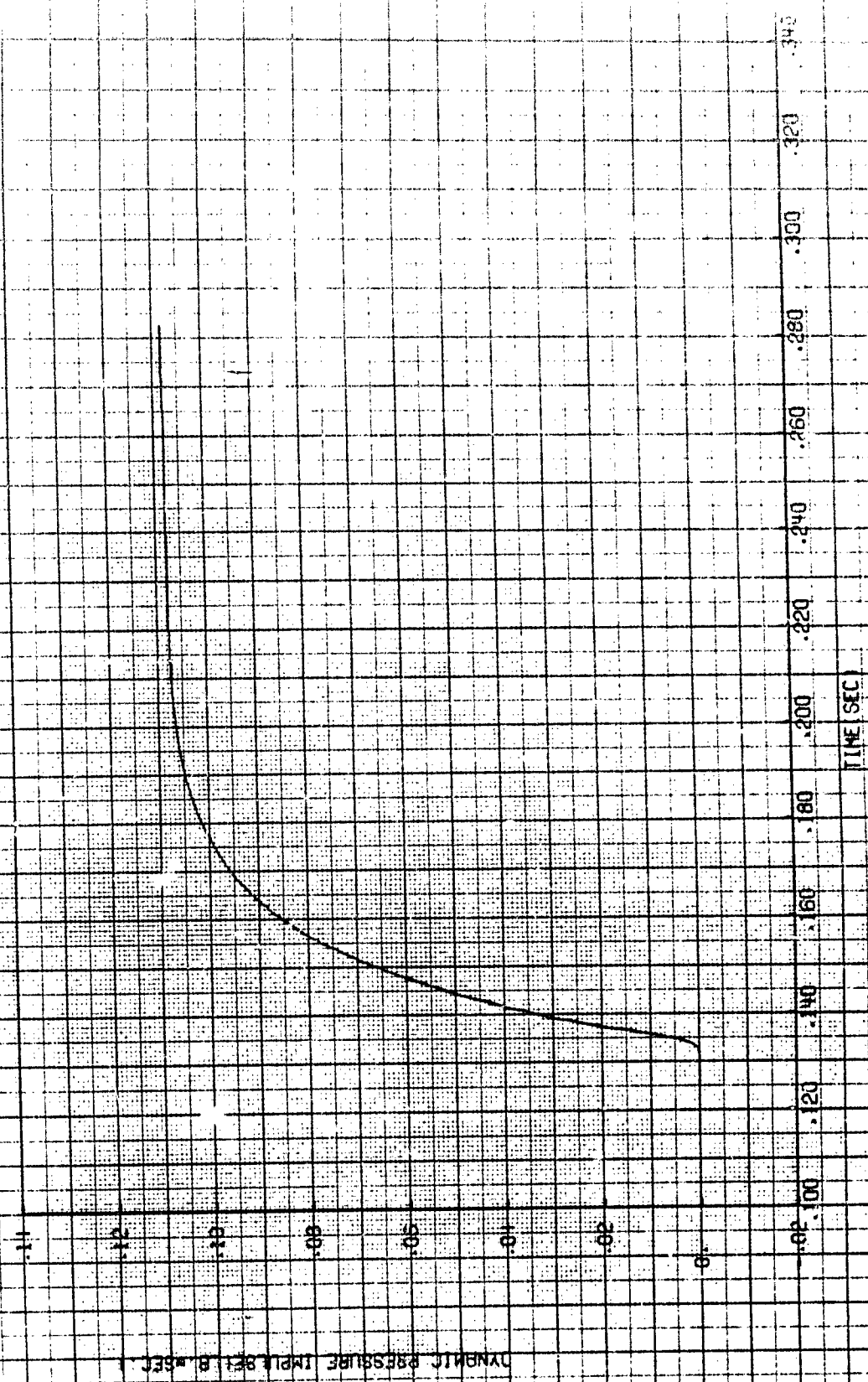


MOISTURE DYNAMIC PRESSURE VS TIME STATION NUMBER 8



280

HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 9



OVER PRESSURE VS TIME STATION NUMBER 10

140.041

120.021

100.001

80.000

60.000

40.000

20.000

0

140.041

120.021

100.001

80.000

60.000

40.000

20.000

0

140.041

120.021

100.001

80.000

60.000

40.000

20.000

0

TIME (SEC)

0.000

0.040

0.080

0.120

0.160

0.200

0.240

0.280

0.320

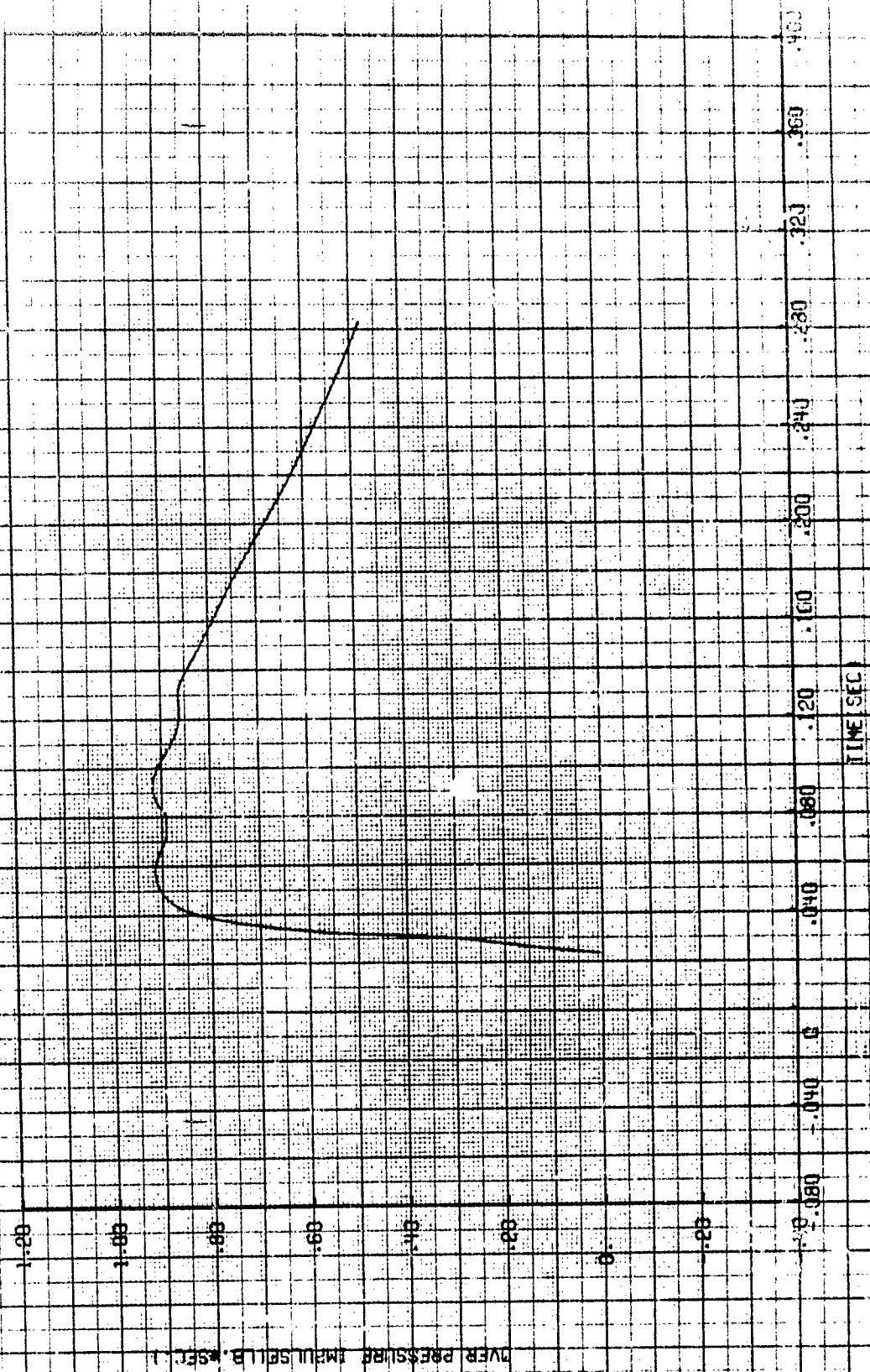
0.360

0.400

OVER PRESSURE (PSI)

282

OVER PRESSURE IMPULSE VS TIME STATION NUMBER 10



NON-FLAME COMPONENT ANALYSIS - 10

2000-00

2100-00

2200-00

2300-00

2400-00

2500-00

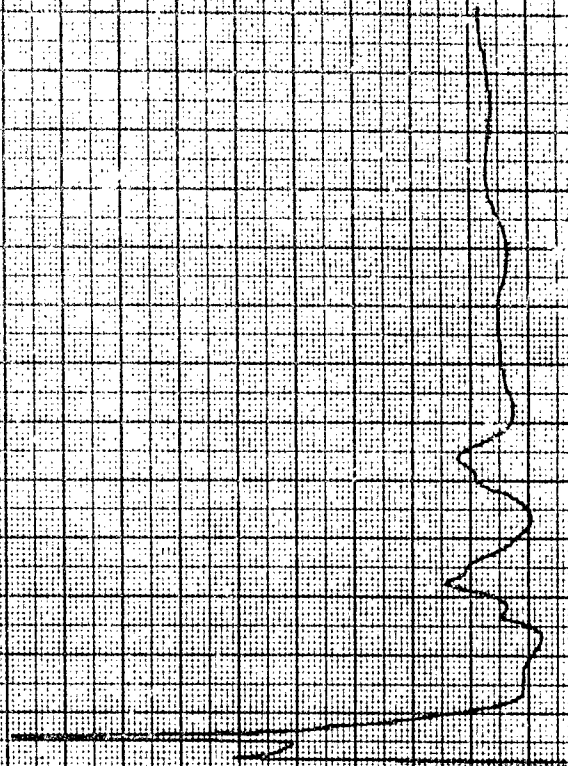
2600-00

0

2700-00

1387 13103333

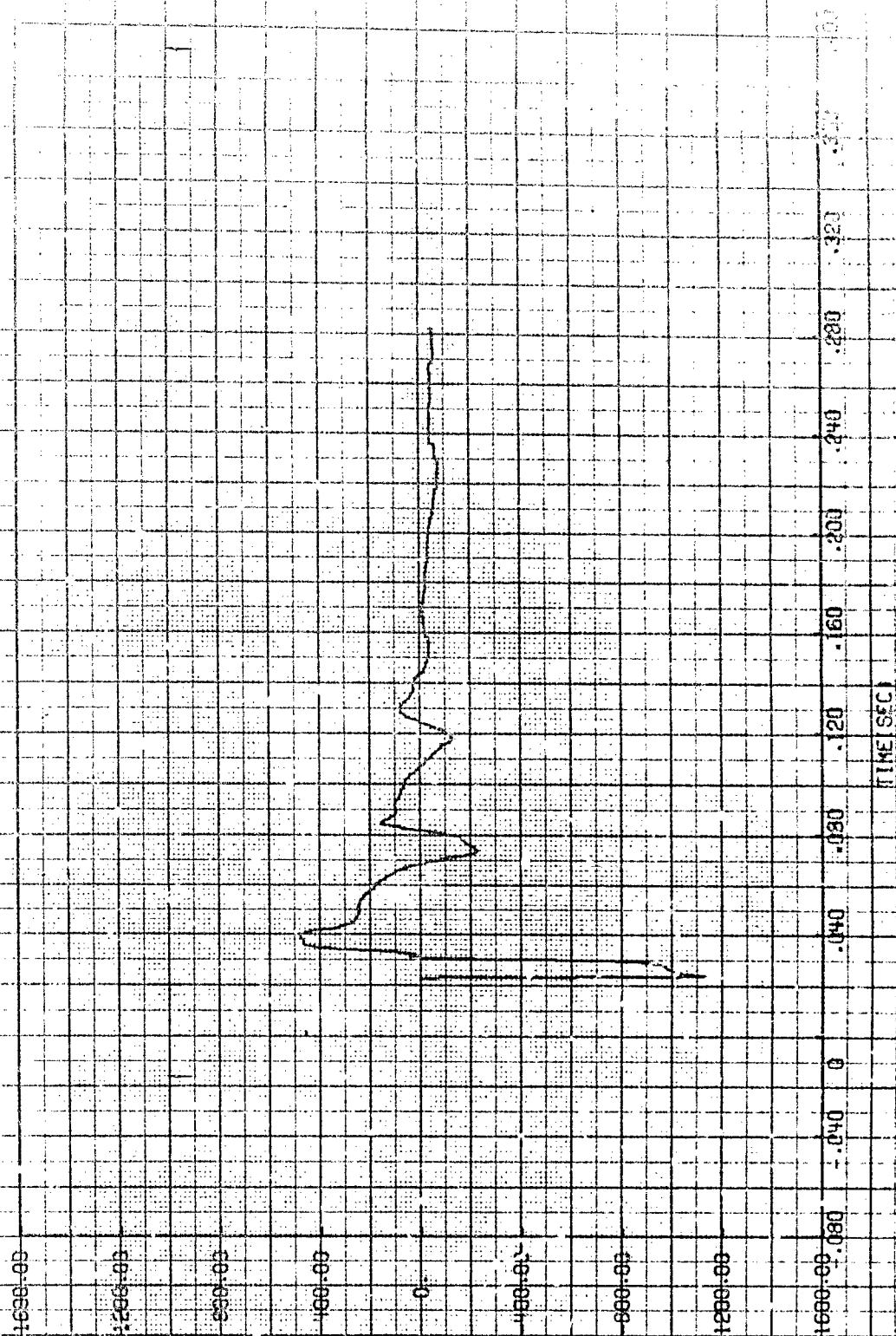
244



0.040 0.080 0.120 0.160 0.200 0.240 0.280 0.320 0.360 0.400

TIME SEC

VERTICAL COMPONENT VELOCITY VS TIME - STATION NUMBER 10



STATION 10

VERTICAL DYNAMIC RESPONSE VS TIME STATION NUMBER 10

140.00

120.00

100.00

80.00

60.00

40.00

20.00

0

0.00 0.080

0.040

0

0.040

0.080

0.120

0.160

0.200

0.240

0.280

0.320

0.360

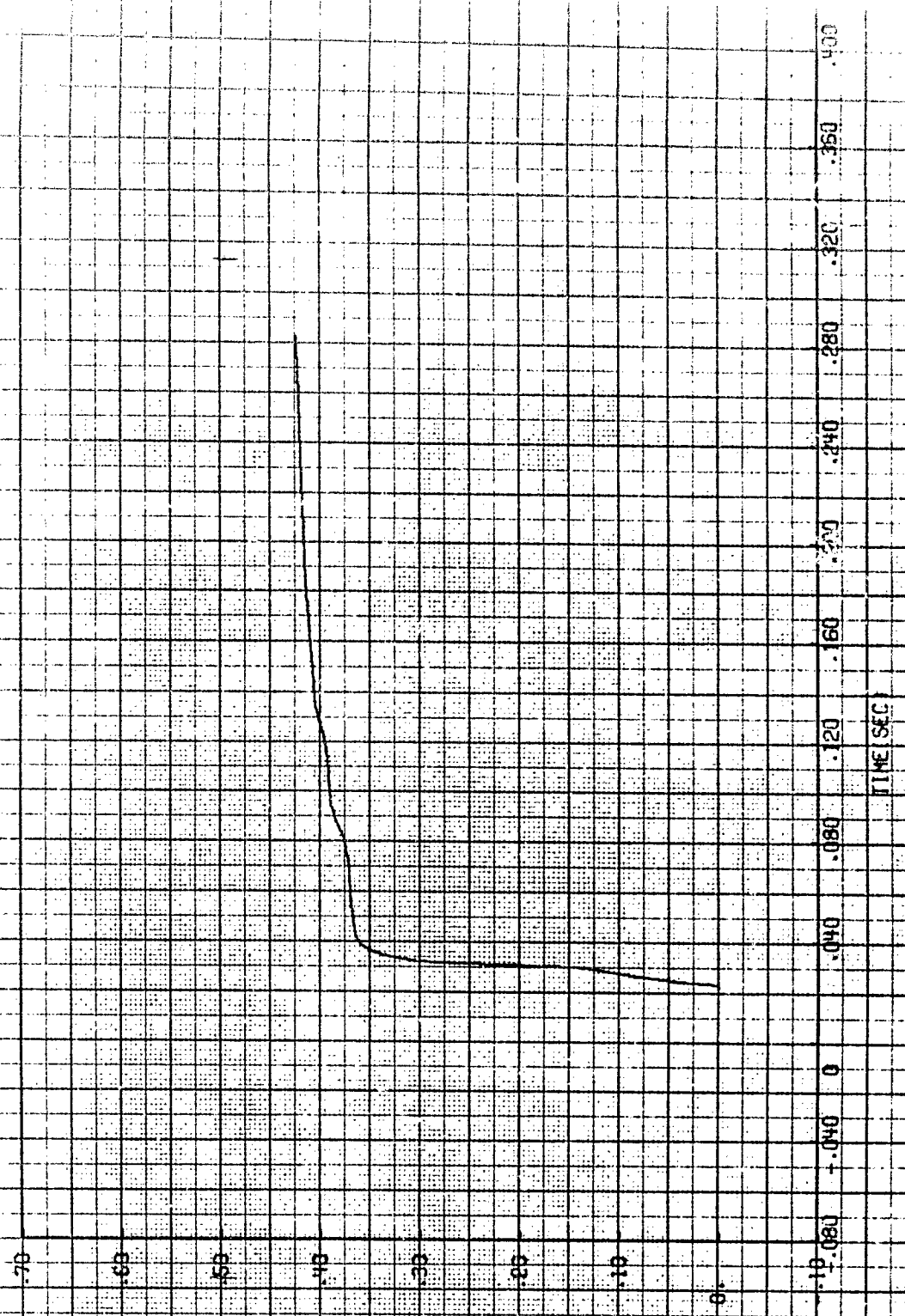
0.400

DYNAMIC PRESSURE (PSI)

286

TIME SEC

HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 10



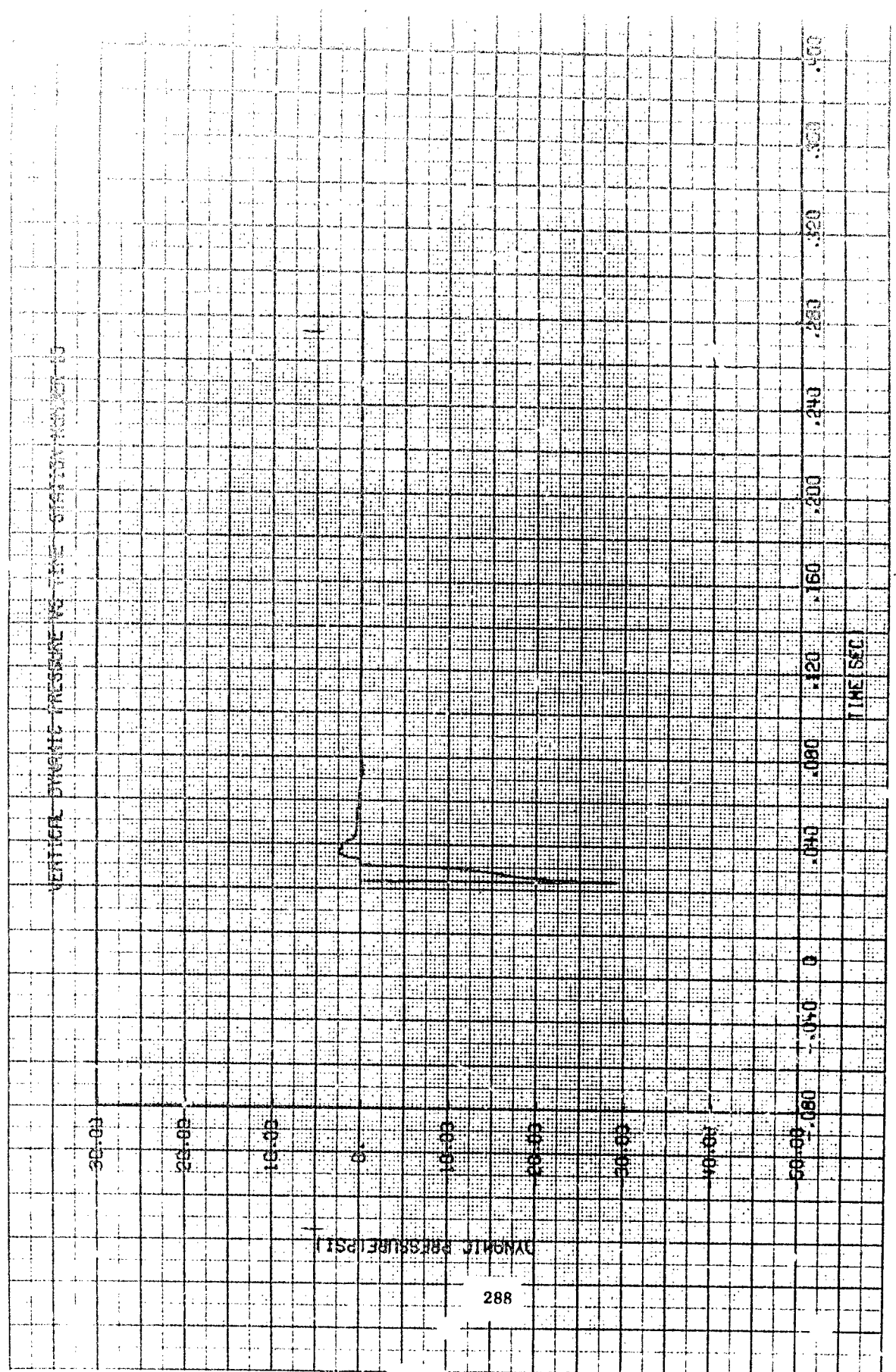
DYNAMIC PRESSURE IMPULSE (LBS. S.F. IN.²)

TIME (SEC)

VERTICAL DYNAMIC PRESSURE VS TIME - STATION NUMBER 13

DYNAMIC PRESSURE (PSI)

TIME (SEC)



VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 10

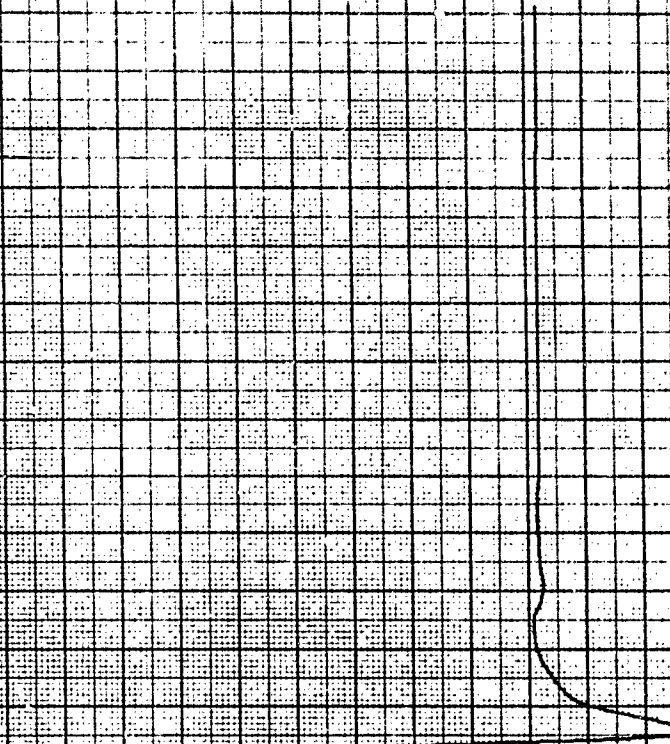
.01
.02
0
.02
.04
.06
.08
.10

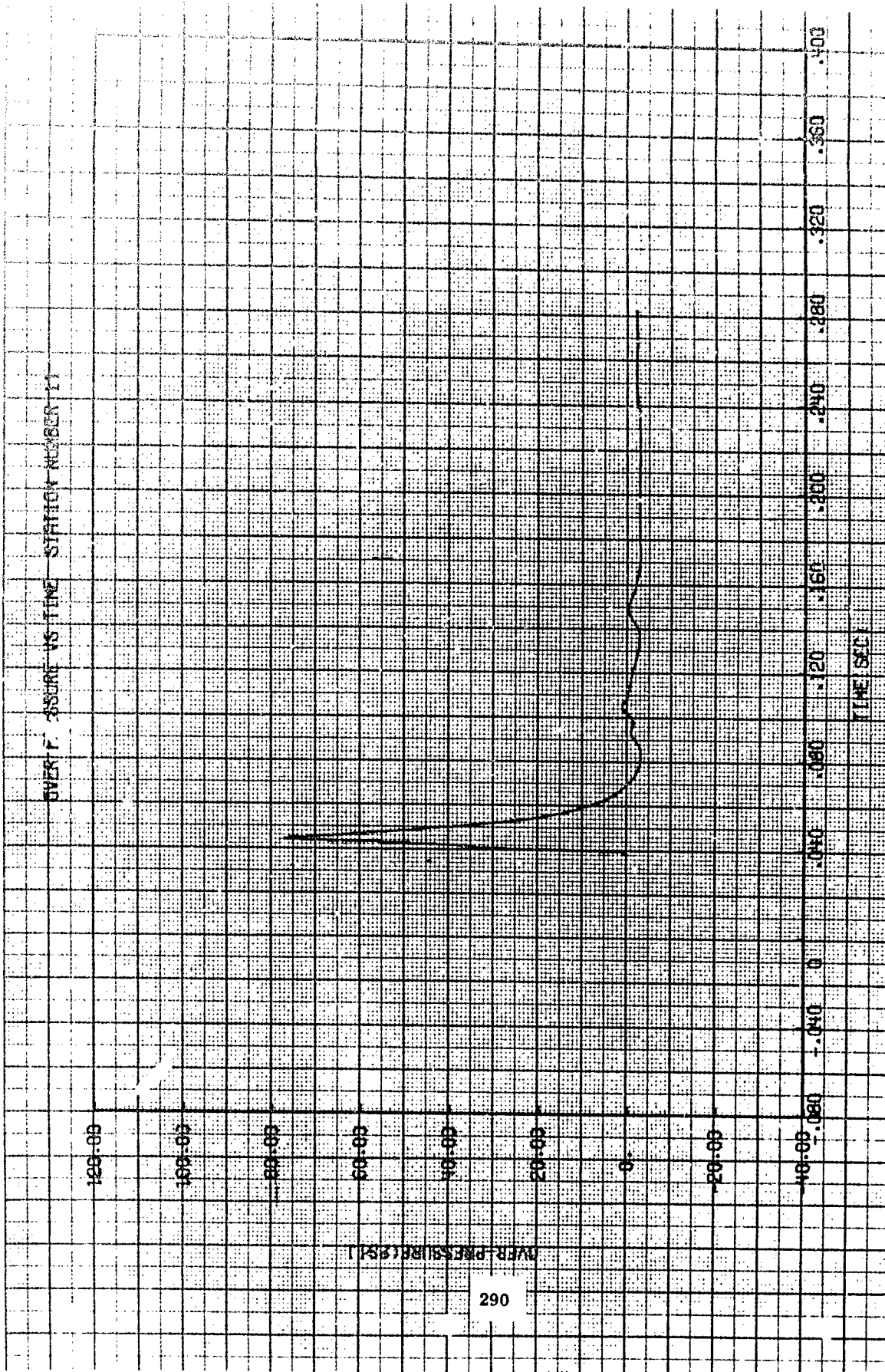
DYNAMIC PRESSURE IMPULS SET 8, REF. 1

289

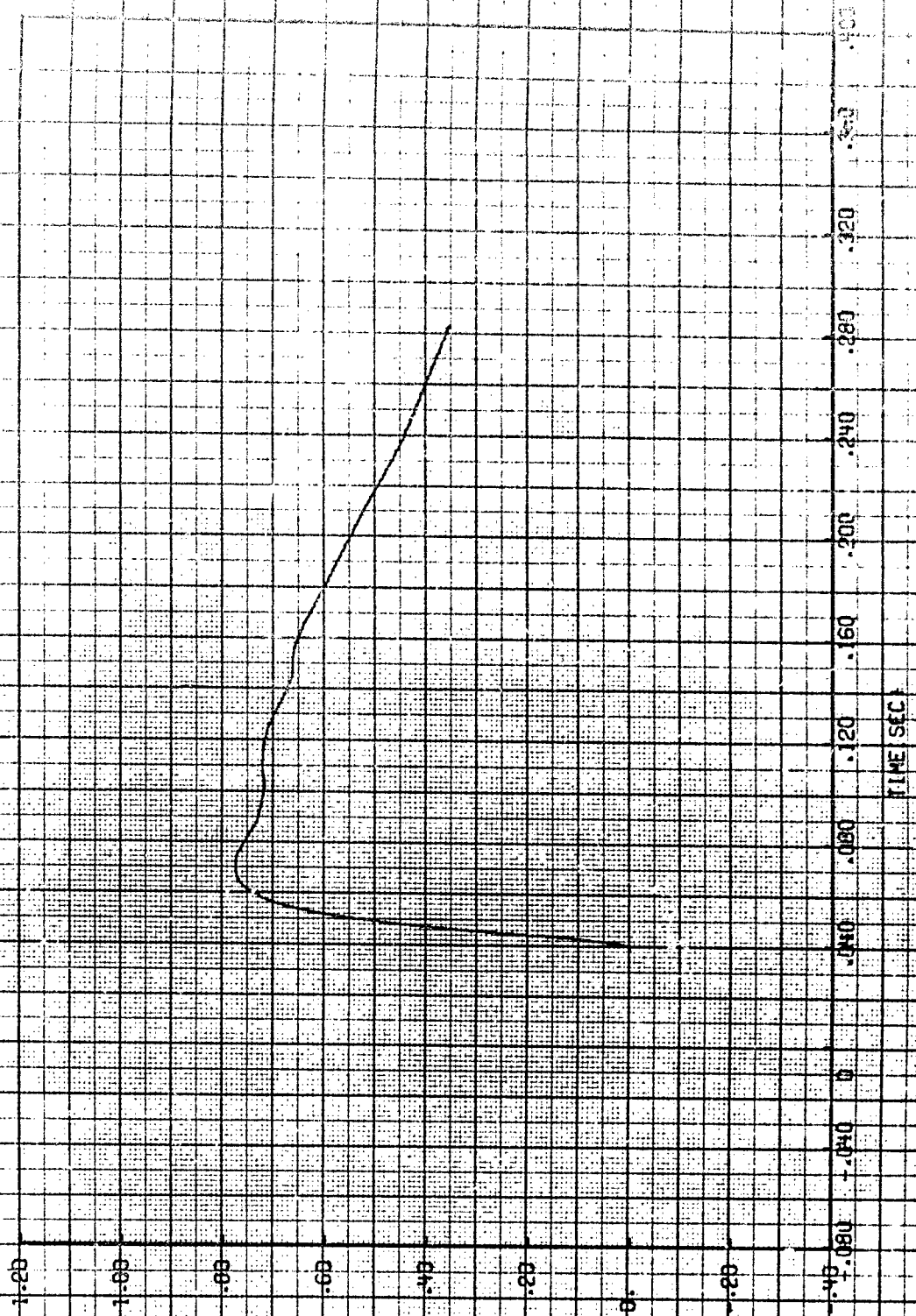
.12 .080 -.040 0 .040 .080 .120 .160 .200 .240 .280 .320 .360 .400

TIME (SEC)



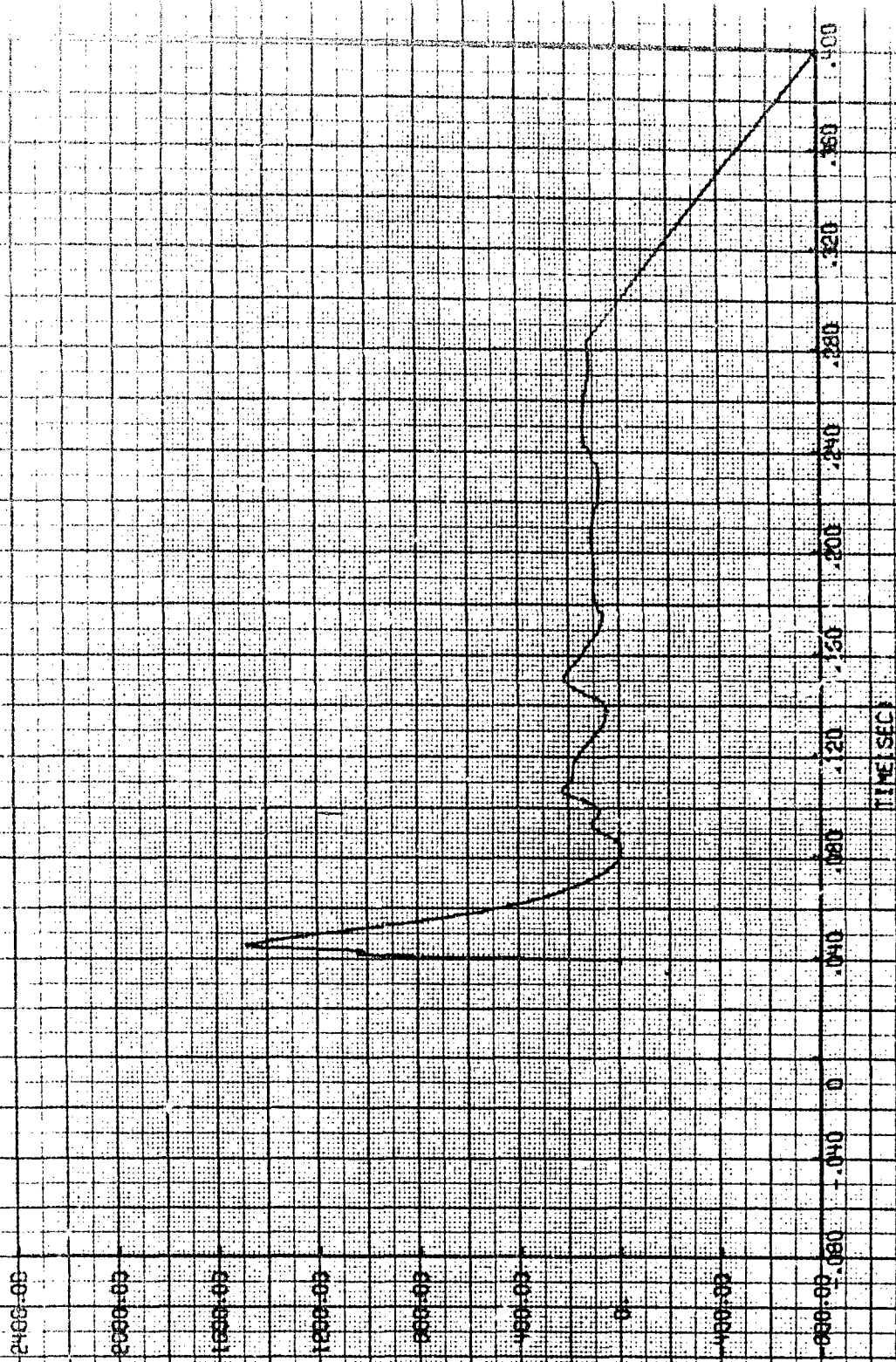


OVER PRESSURE IMPULSE VS TIME STATION NUMBER 11



OVER PRESSURE IMPULSE (LB. SEC.)

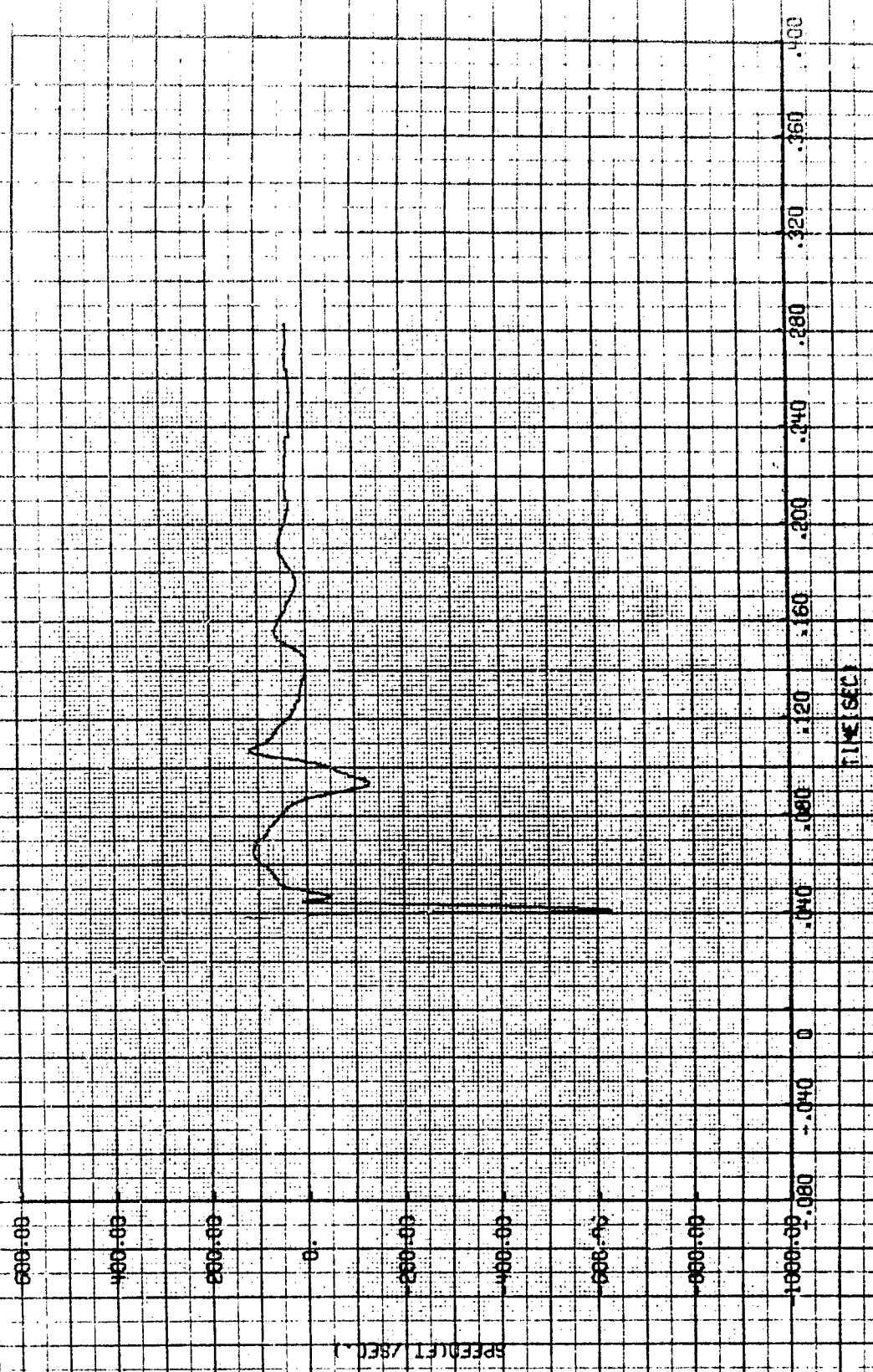
HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 11



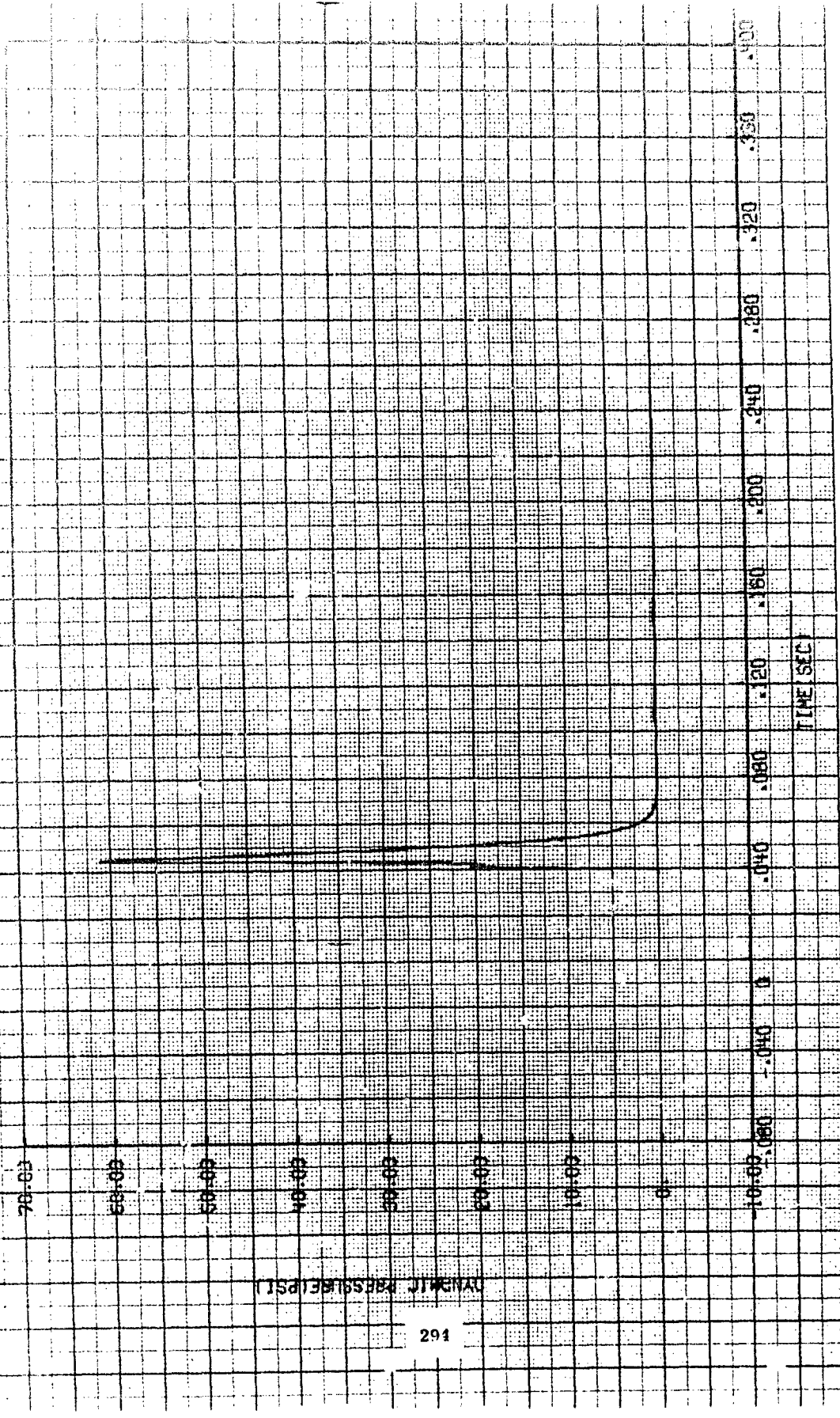
VELOCITY (FT/SEC)

TIME (SEC)

VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 11



HORIZONTAL DYNAMIC PRESSURE VS TIME - STATION NUMBER 41



DYNAMIC PRESSURE (PSI)

TIME (SEC)

VERTICAL DYNAMIC PRESSURE VS TIME STATION NUMBER 11

6.00

4.00

2.00

0.00

-2.00

-4.00

-6.00

-8.00

-10.00

DYNAMIC PRESSURE (PSI)

295

.400

.360

.320

.280

.240

.200

.160

.120

.080

.040

0

-.040

-.080

-.120

-.160

-.200

-.240

-.280

-.320

-.360

-.400

TIME (SEC)

HORIZONTAL DYNAMIC PRESSURE IMPULSE TO THE STATIONARY DESK

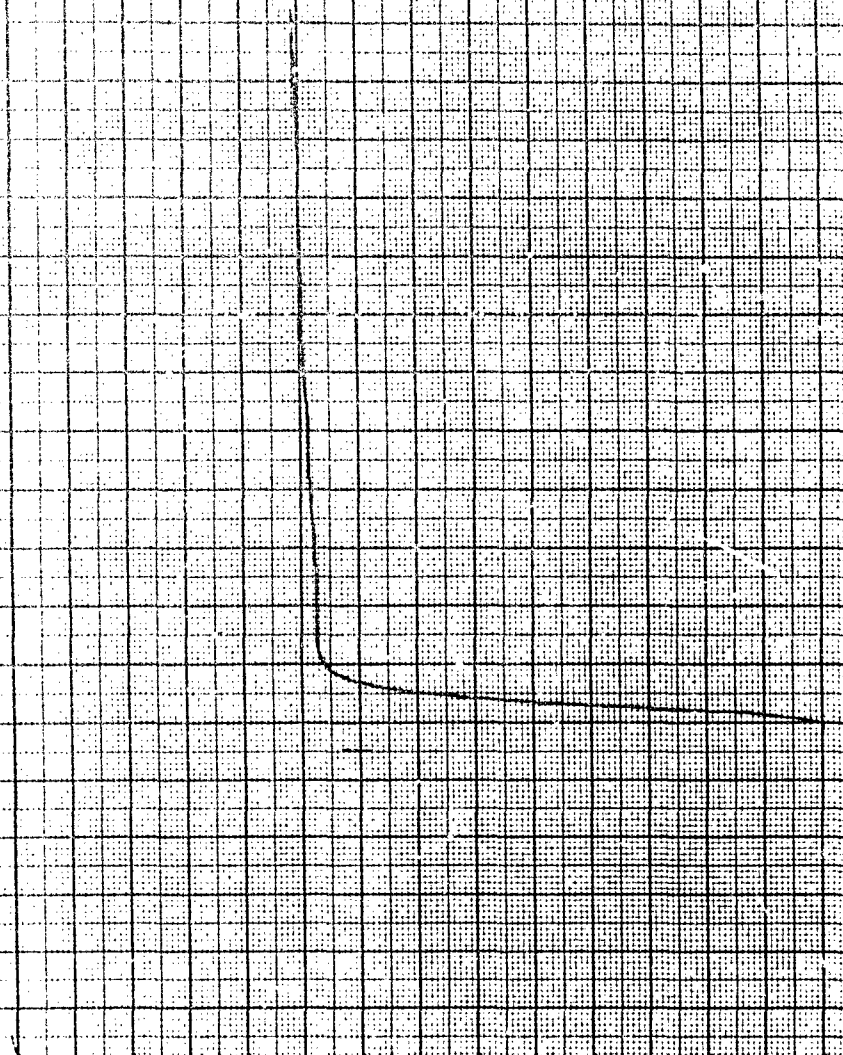
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0

DYNAMIC PRESSURE IMPUL. SET. B. * SEC.

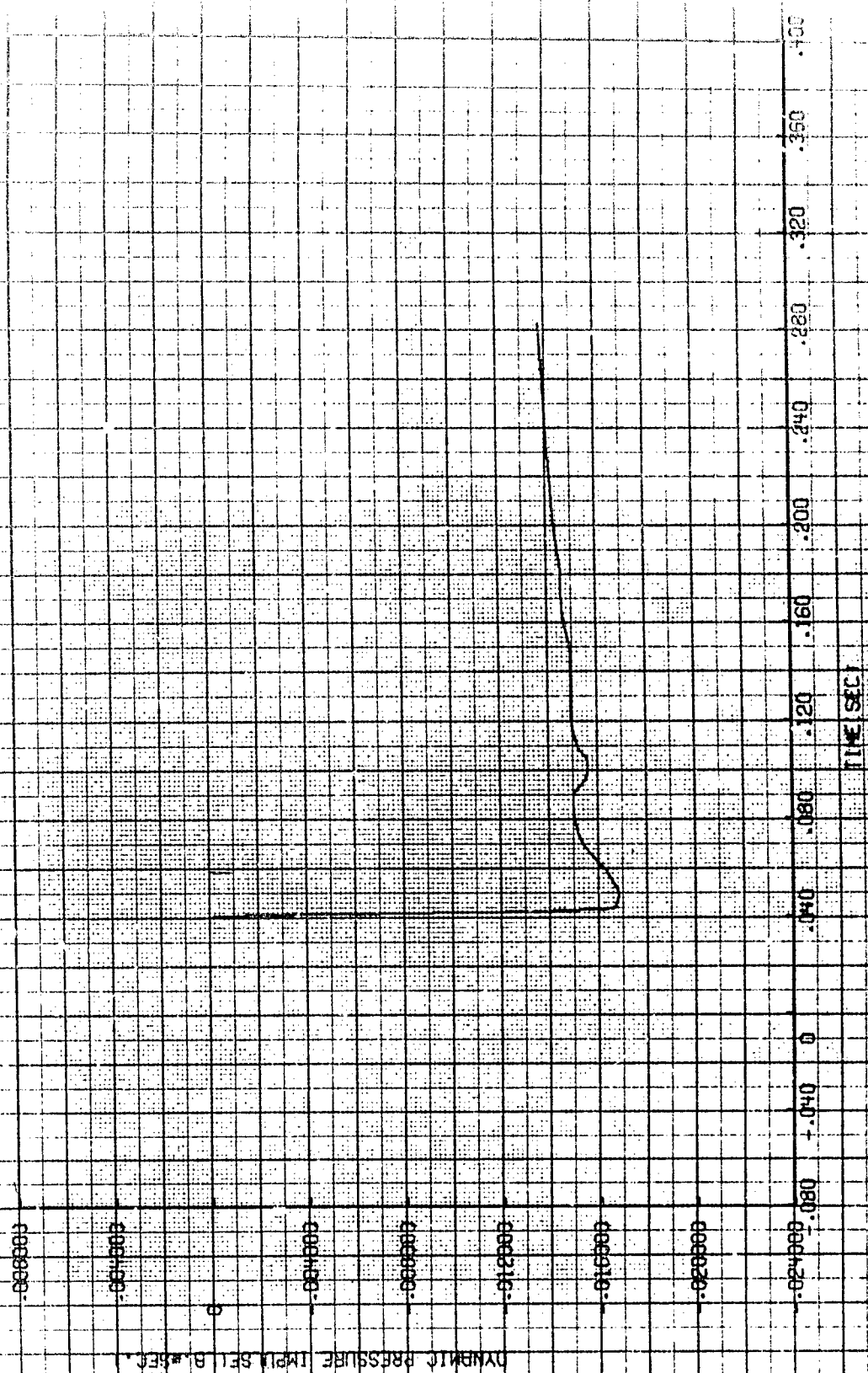
296

0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70 2.80 2.90 3.00 3.10 3.20 3.30 3.40 3.50 3.60 3.70 3.80 3.90 4.00

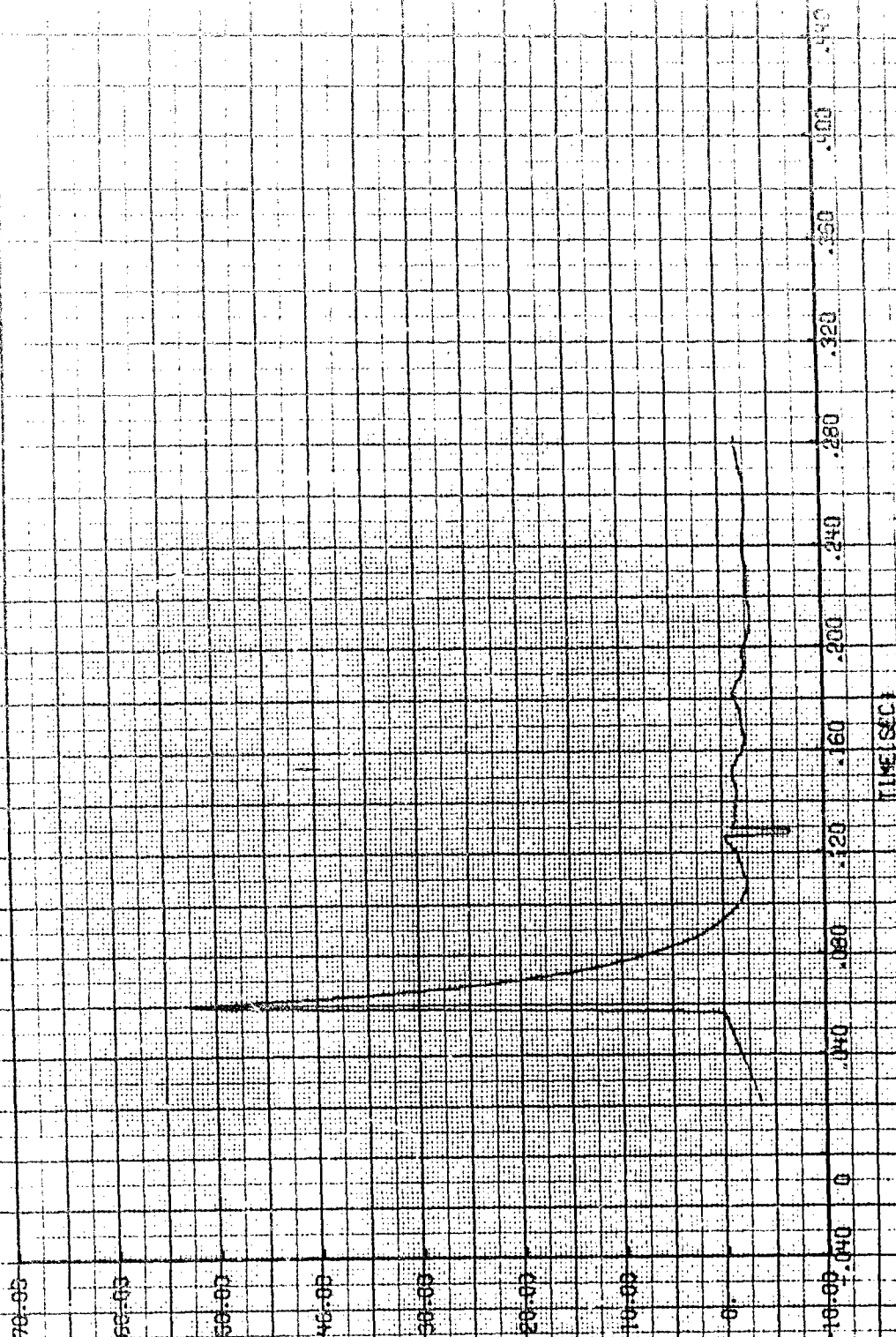
TIME (SEC)



VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 11



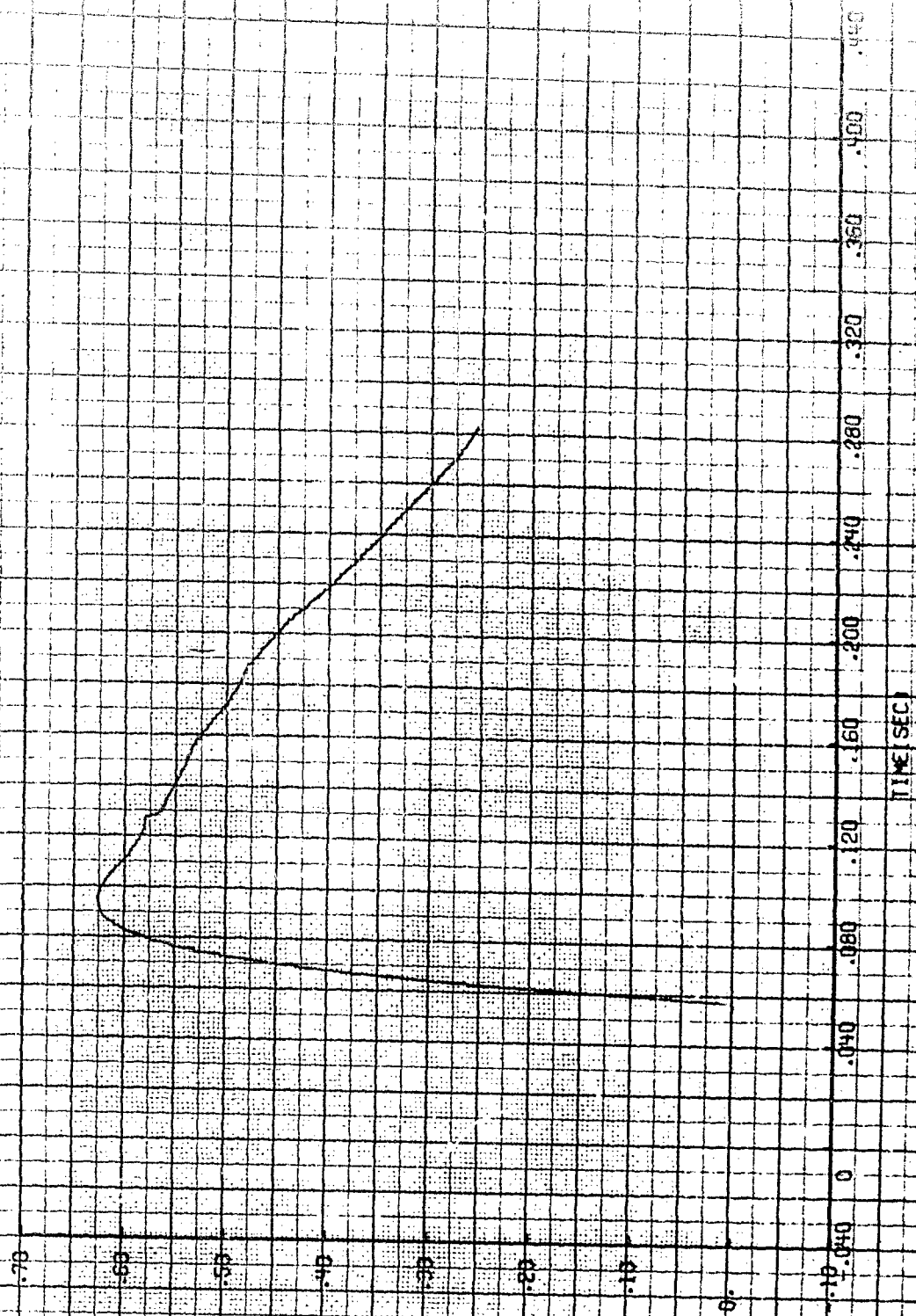
OVER PRESSURE VS TIME - STATIC - 10000000



OVER PRESSURE (PSI)

29P

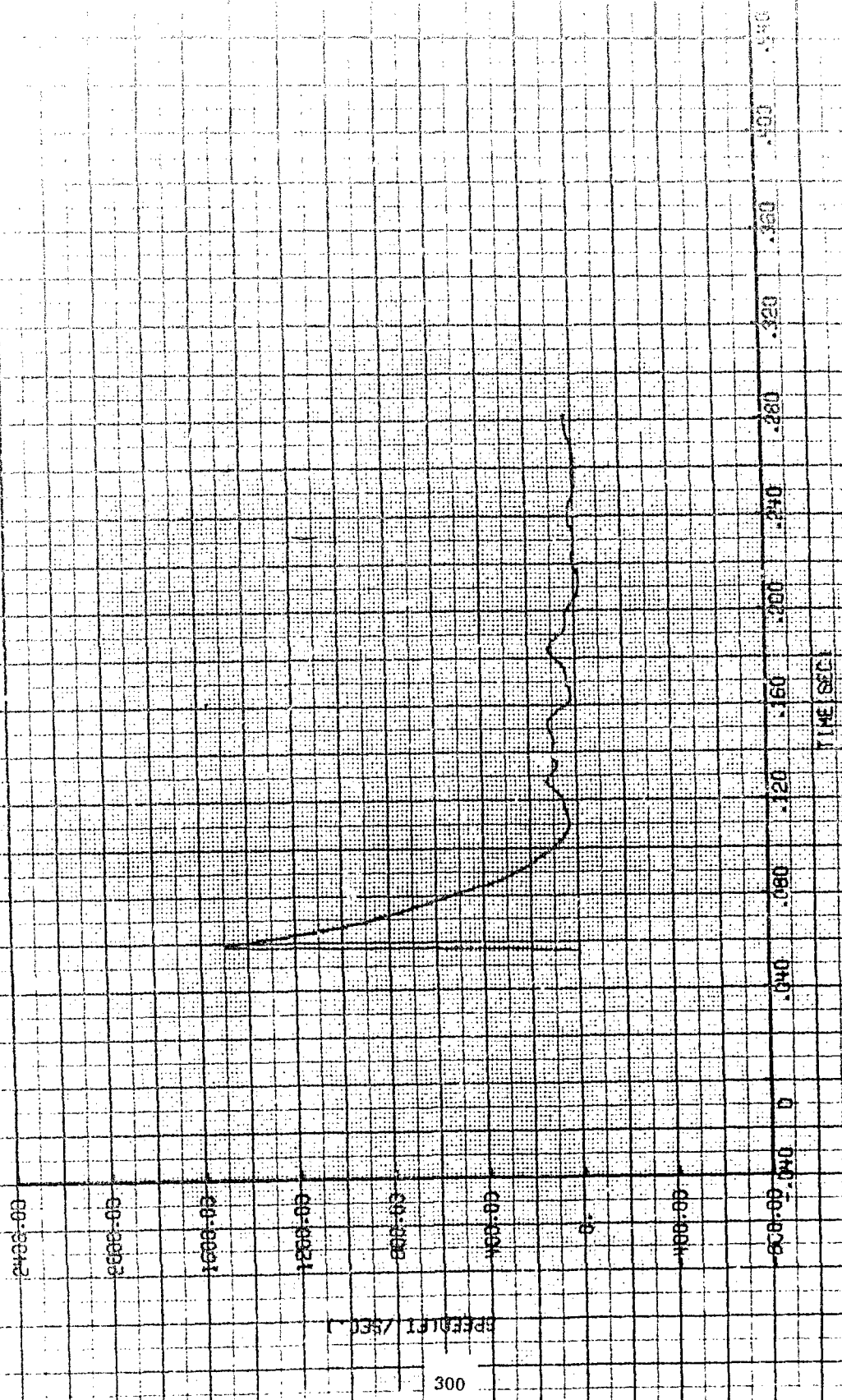
OVER PRESSURE IMPULSE VS TIME STATION NUMBER 12



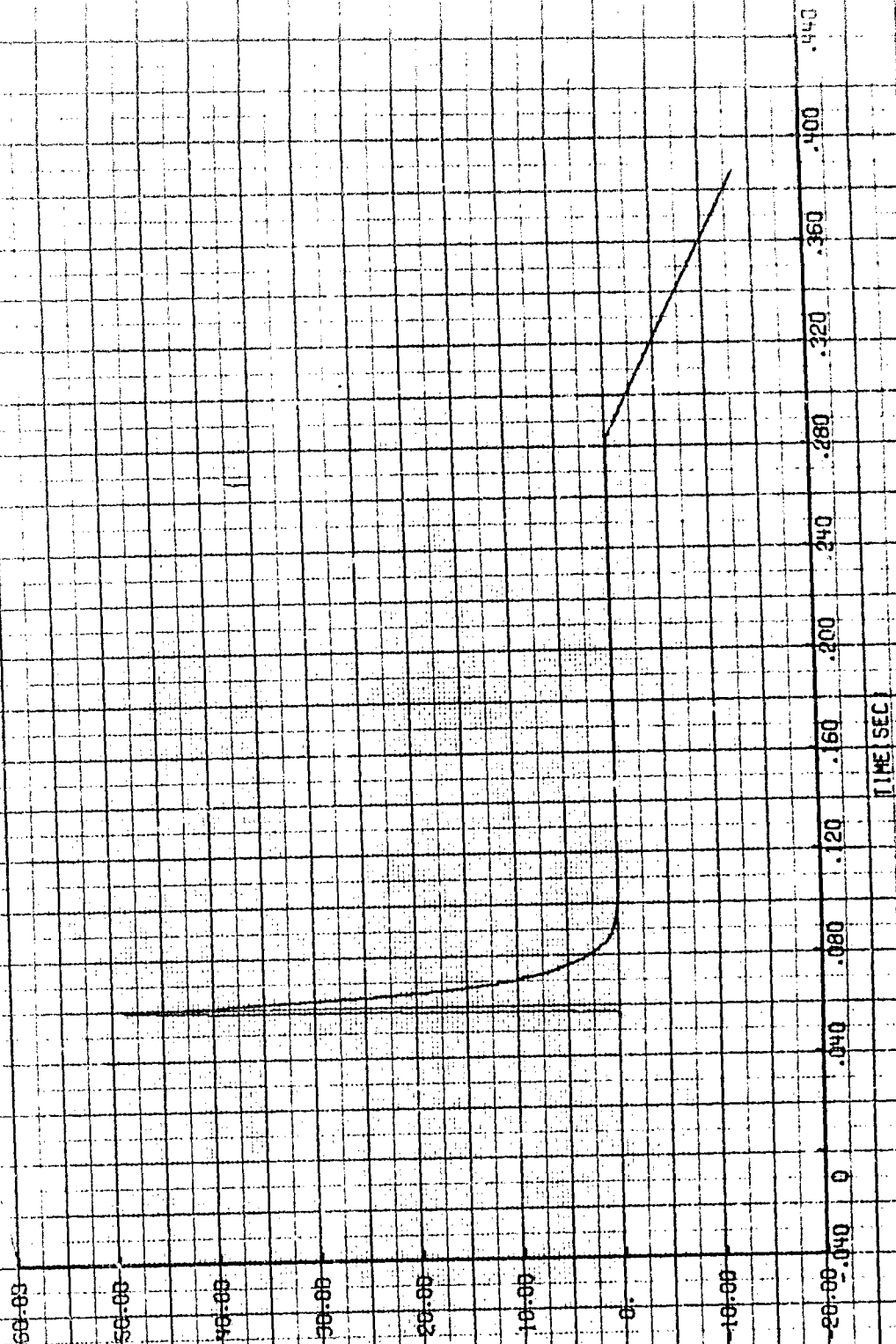
OVER PRESSURE IMPULSE (LBS./SQ. IN. SEC.)

TIME (SEC.)

HORIZONTAL COMPONENT VELOCITY VS TIME - STATION WINDS



HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 12



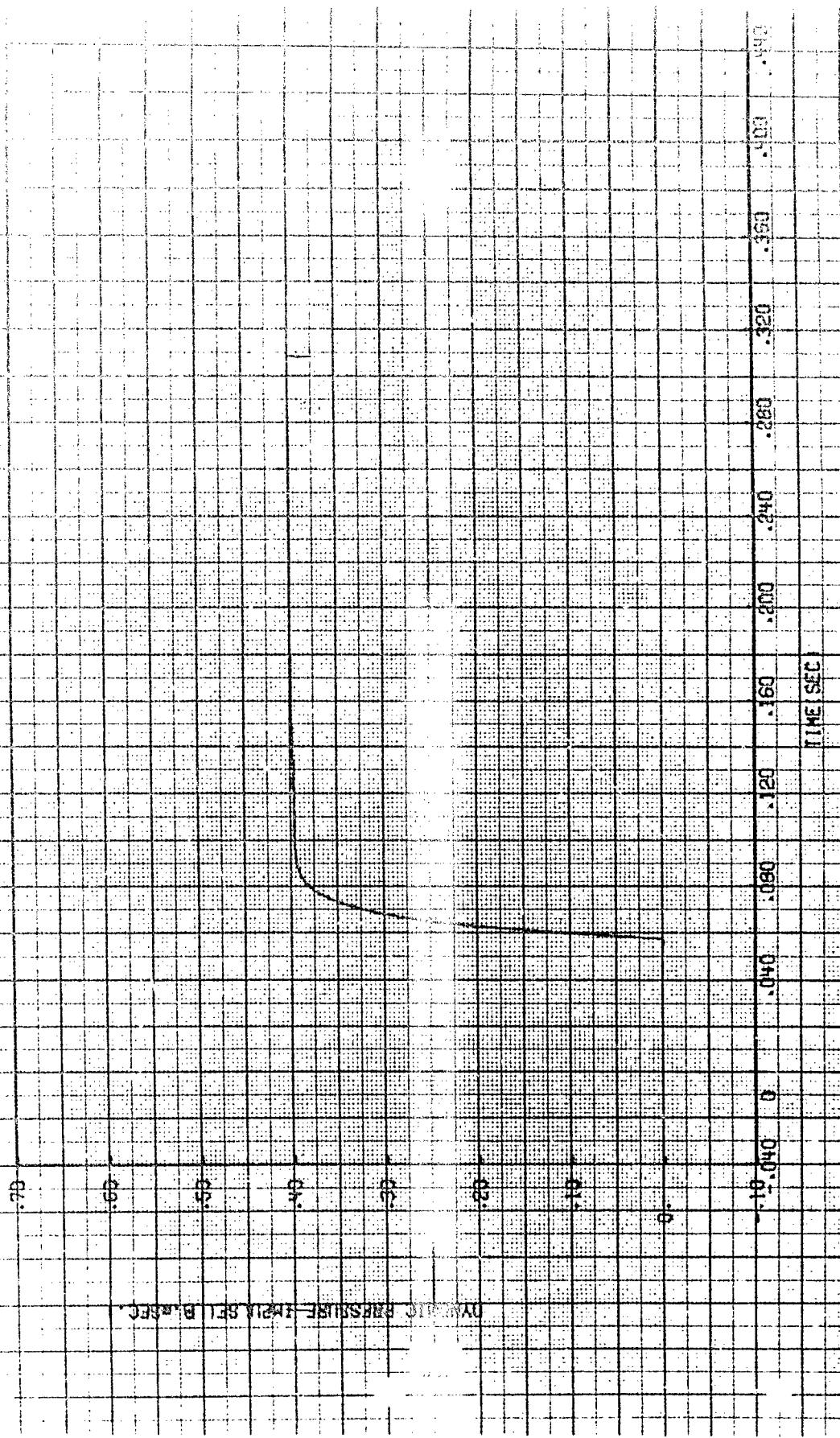
DYNAMIC PRESSURE (PSI)

301

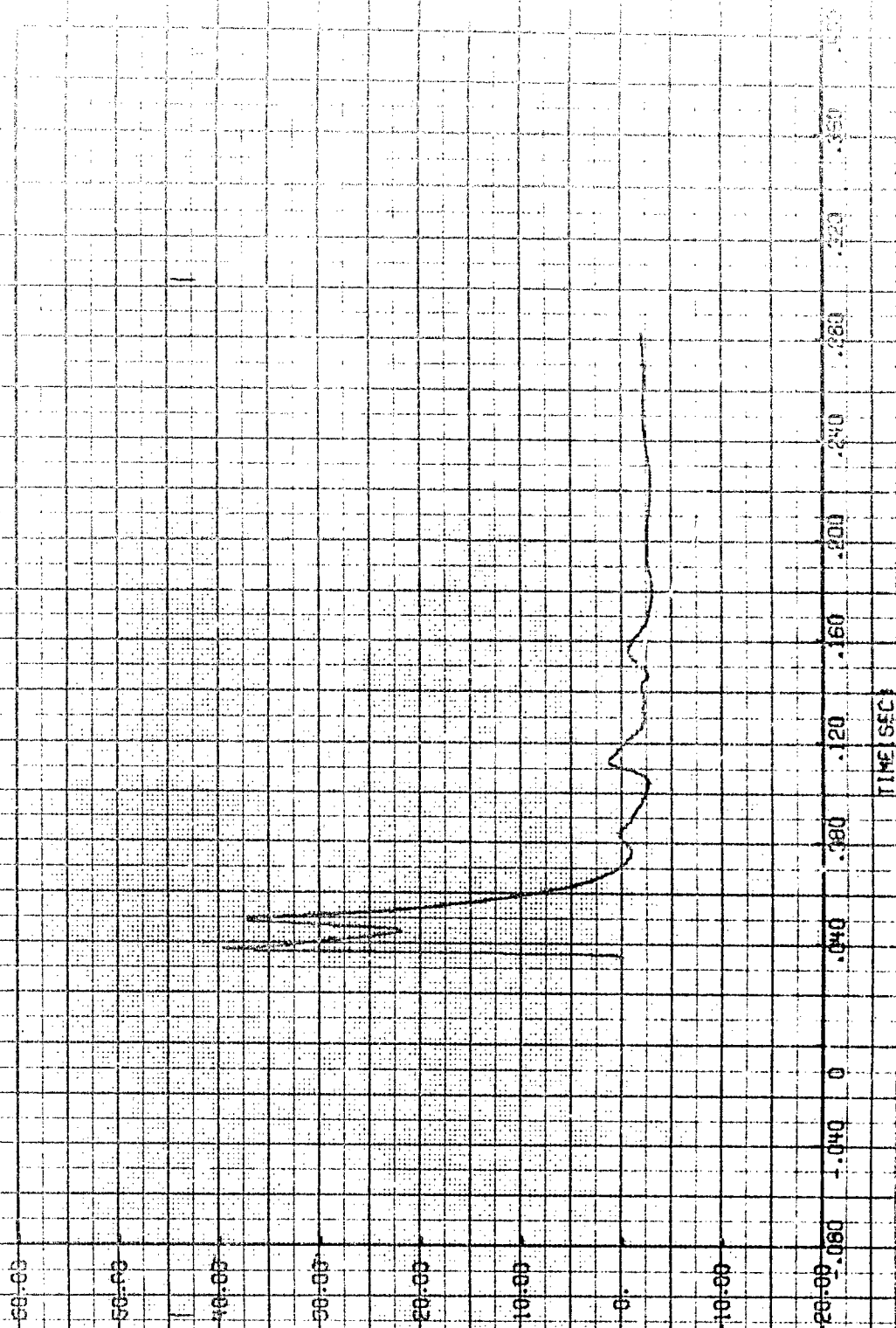
TIME (SEC)

WATERGATE DYNAMIC PRESSURE HISTORY NO. TWO STATION 100000-10

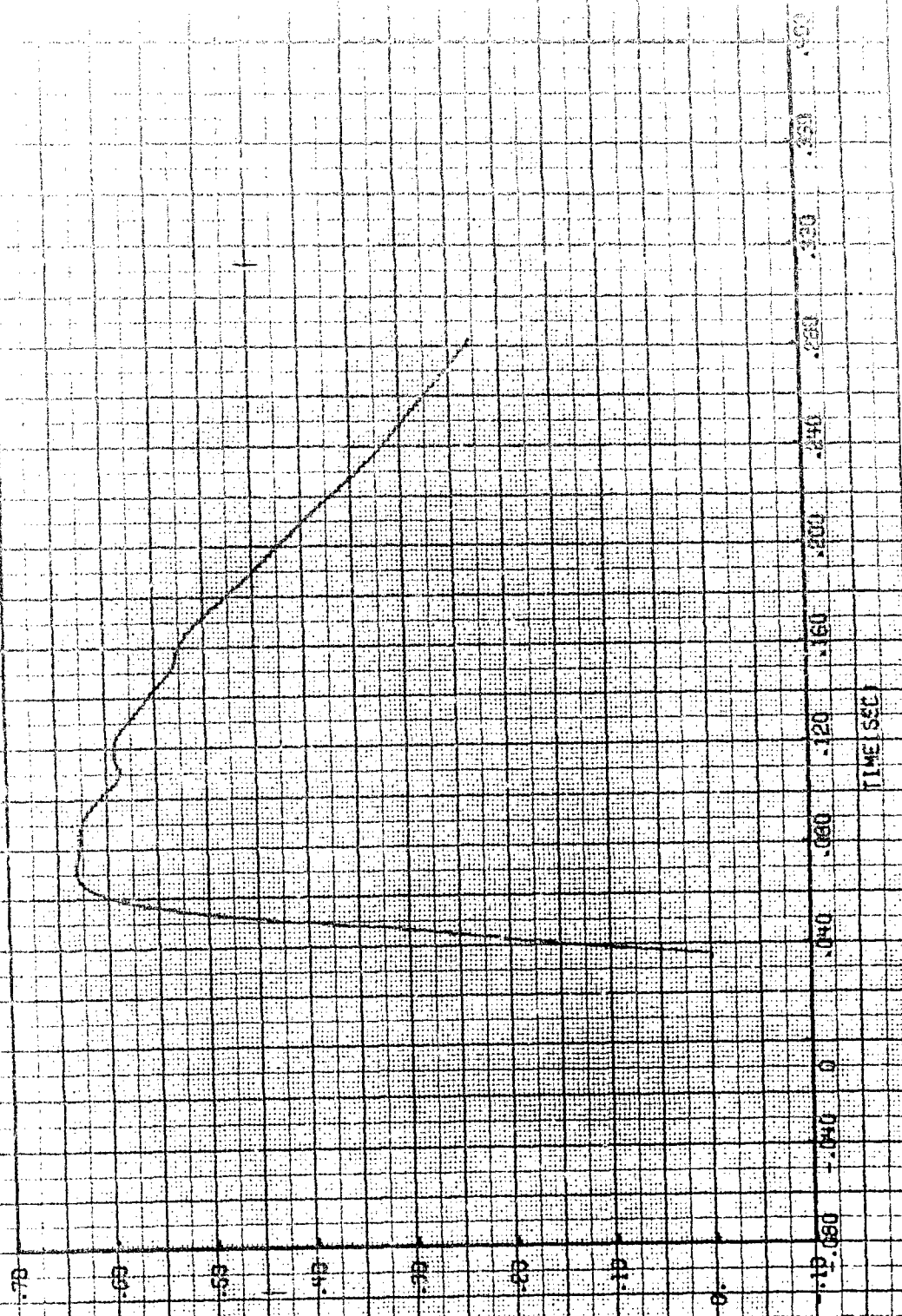
DYNAMIC PRESSURE - MPa (SEI) P. 10 SEC.



OVER-PRESSURE VS TIME (SECONDS)

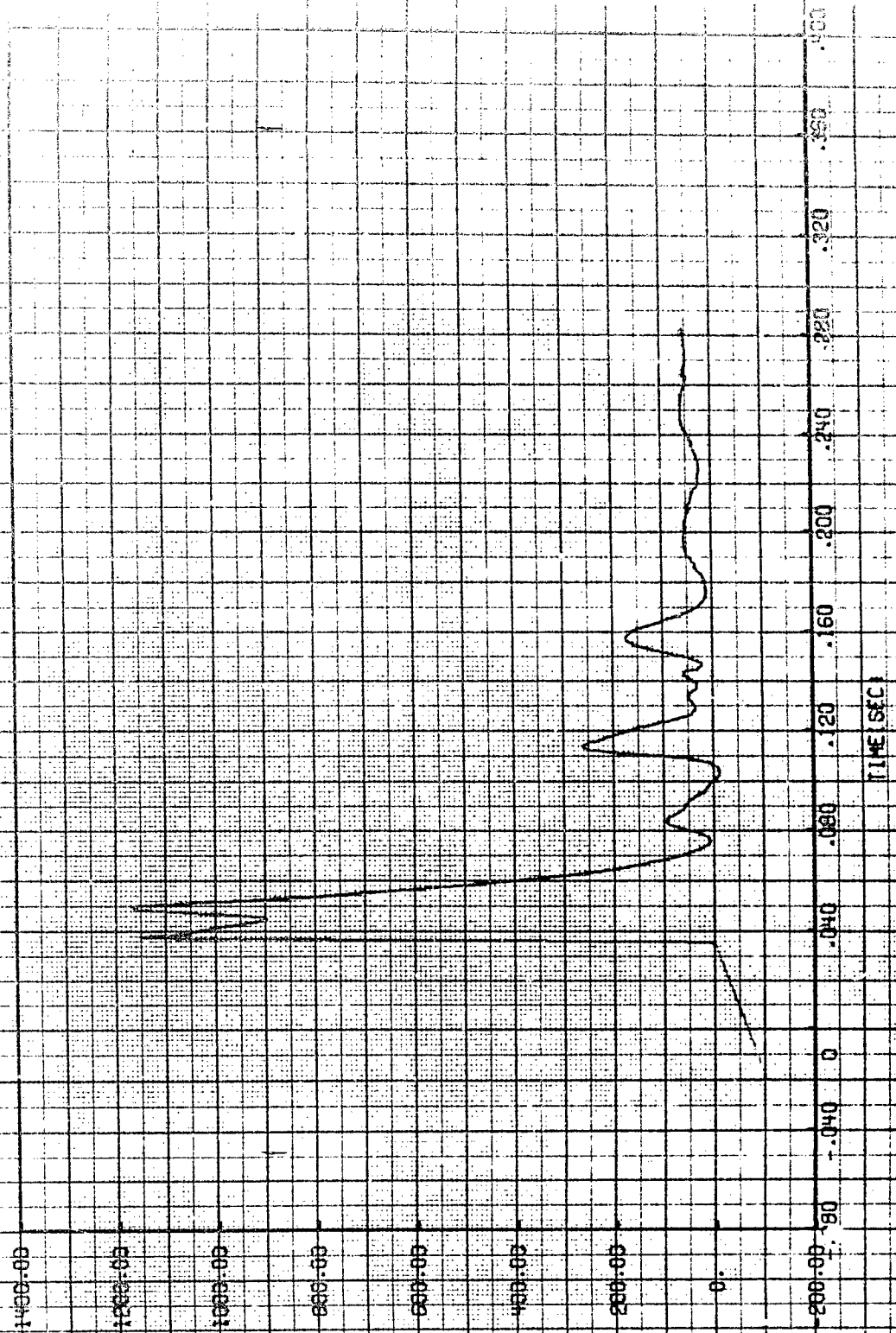


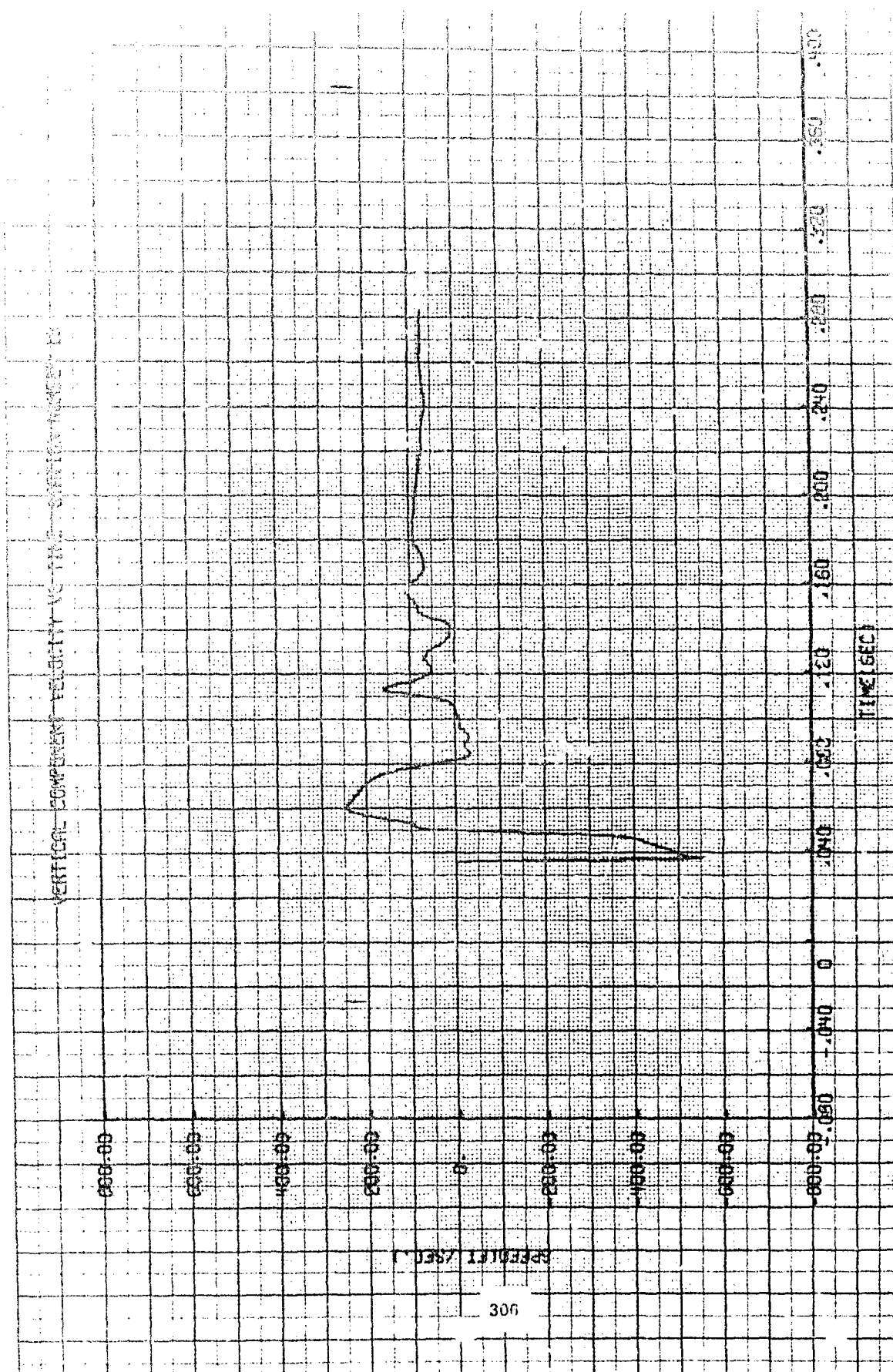
OVER PRESSURE PULSES VS TIME - STATION 0.000



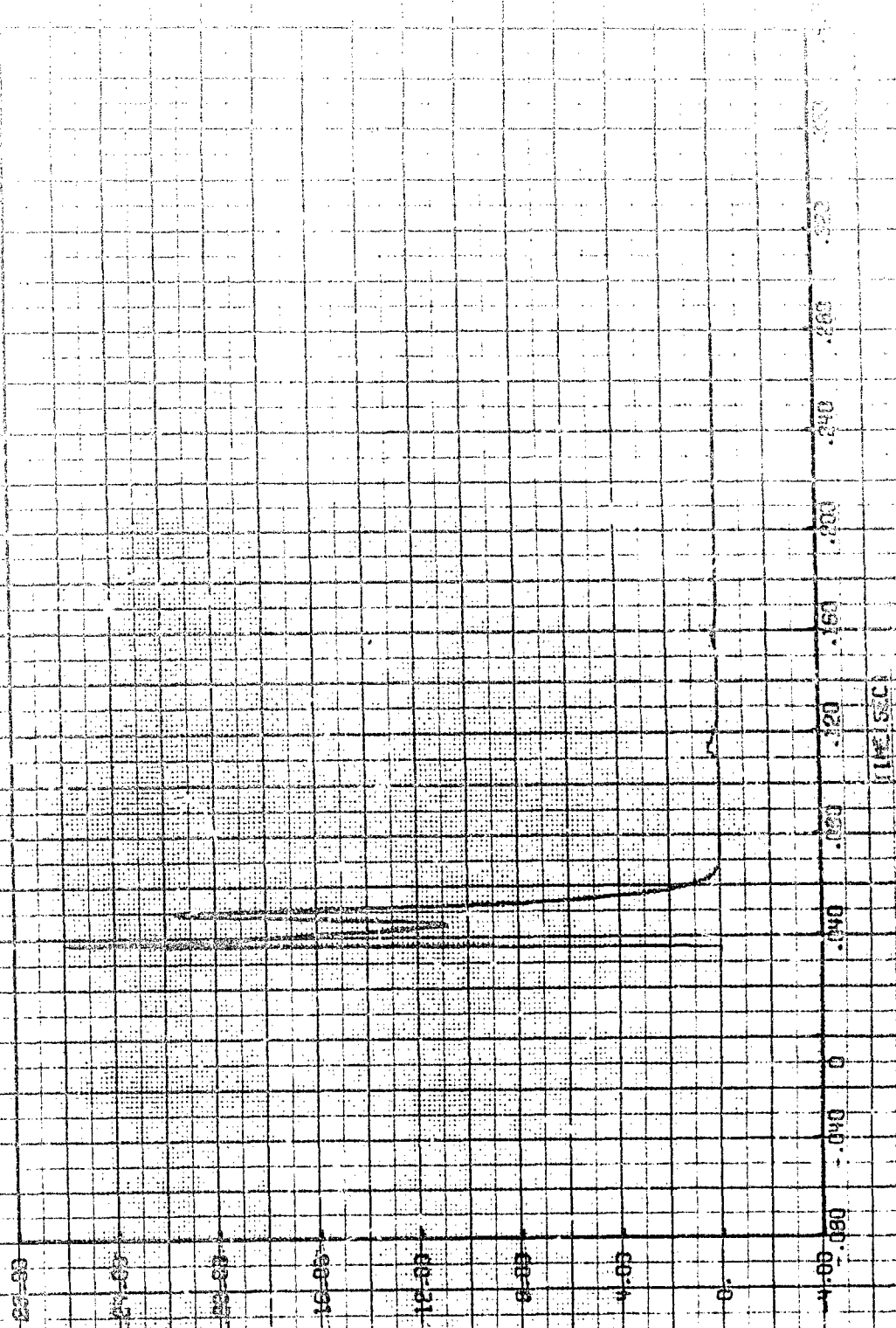
OVER PRESSURE (PULSES/LB-SEC)

HORIZONTAL COMPONENT VELOCITY VS TIME - STATION NUMBER 15

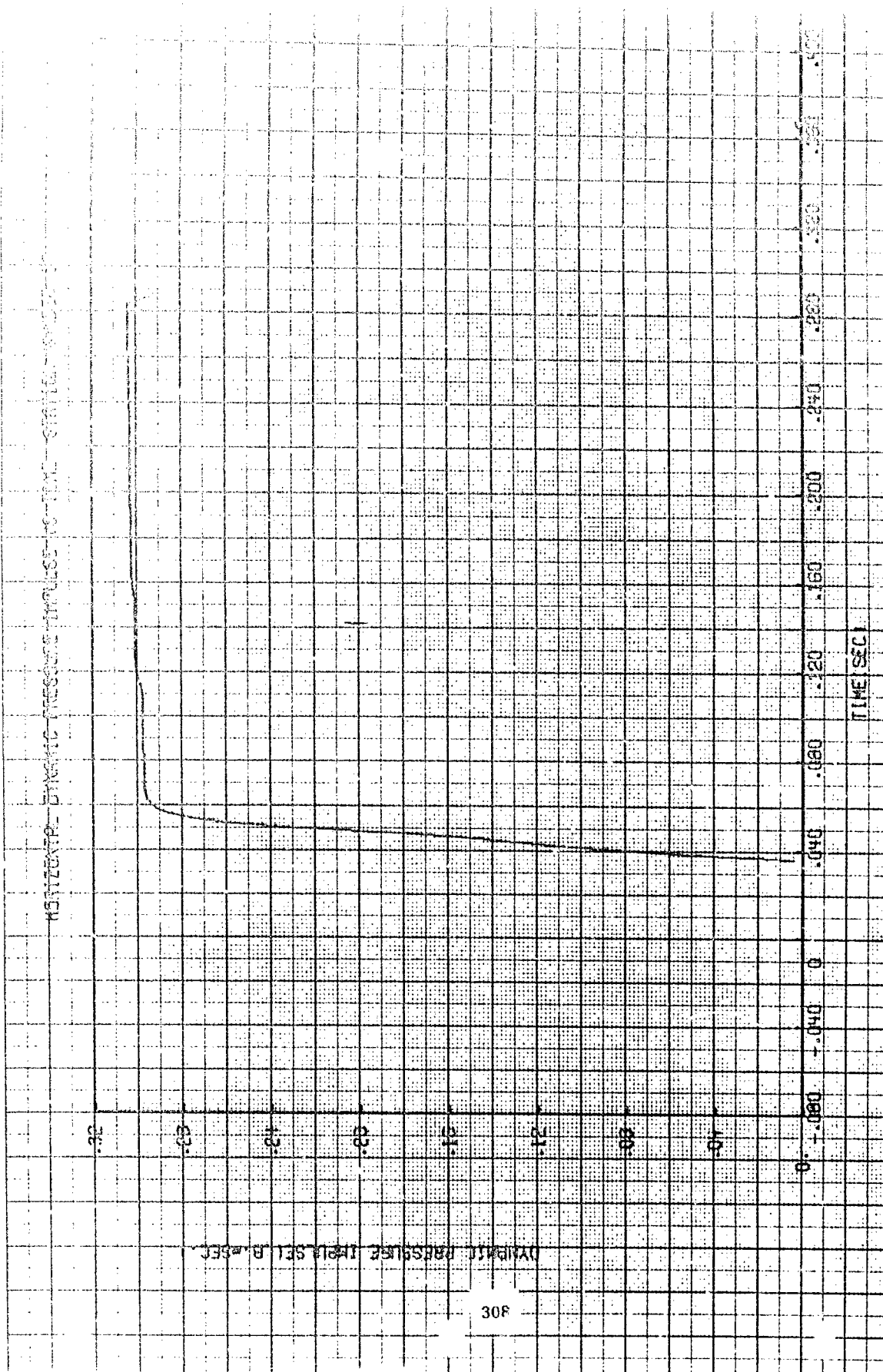




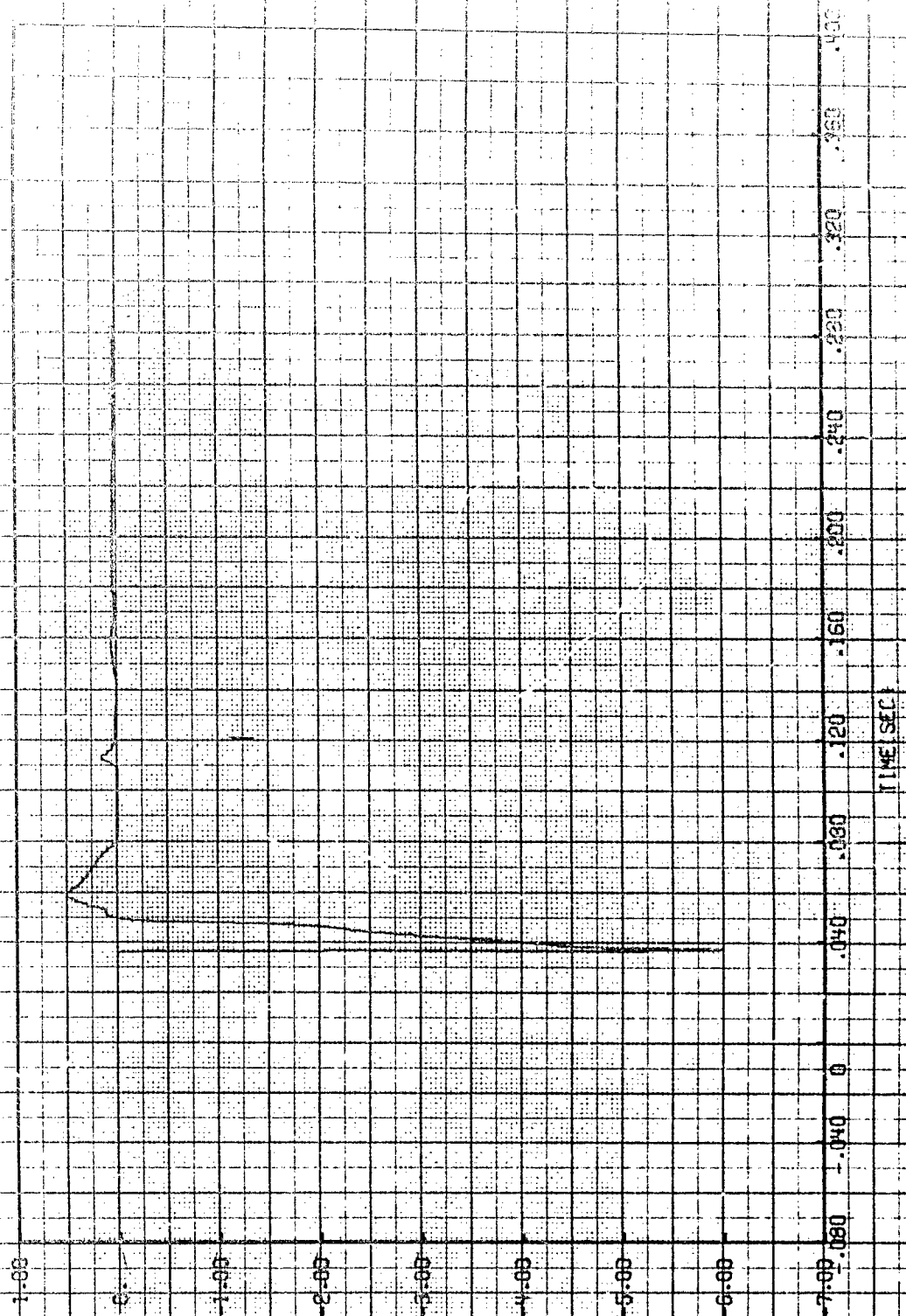
PERCENT DYNAMIC RESPONSE VS TIME - STIFFENING EFFECTS



DYNAMIC RESPONSE



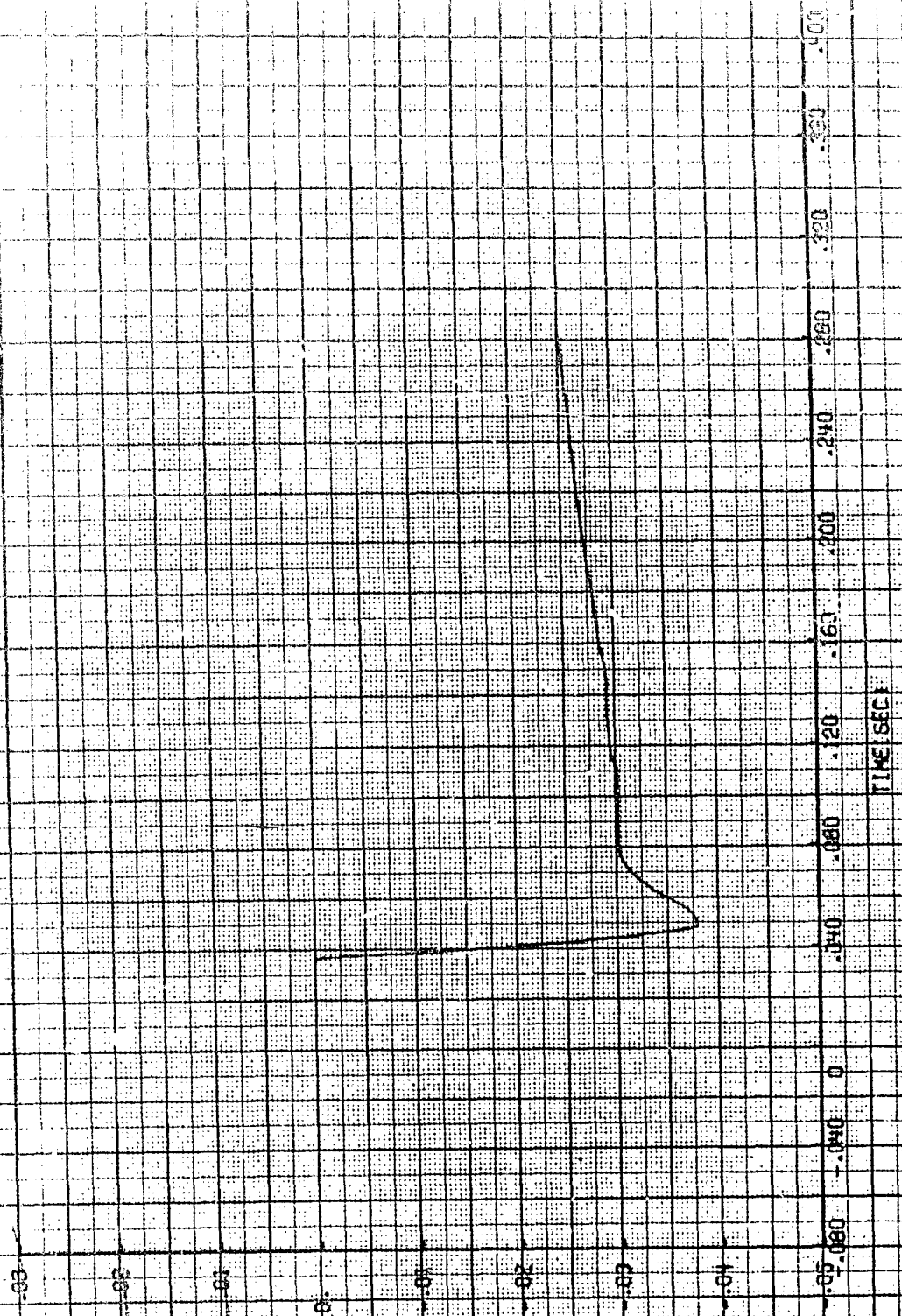
VERTICAL DYNAMIC PRESSURE VS TIME - STATIC NUMBER 15



DYNAMIC PRESSURE (PSI)

TIME (SEC)

VERTICAL DYNAMIC PRESSURE MEASURE TO TIME STARTING POINT IS



OVER PRESSURE VS TIME - STATION HOUSE 14

50.00

40.00

30.00

20.00

10.00

0.

-10.00

-20.00

-30.00

TIME (SEC)

0.00

0.040

0.080

0.120

0.160

0.200

0.240

0.280

0.320

0.360

0.400

0.440

0.480

0.520

0.560

0.600

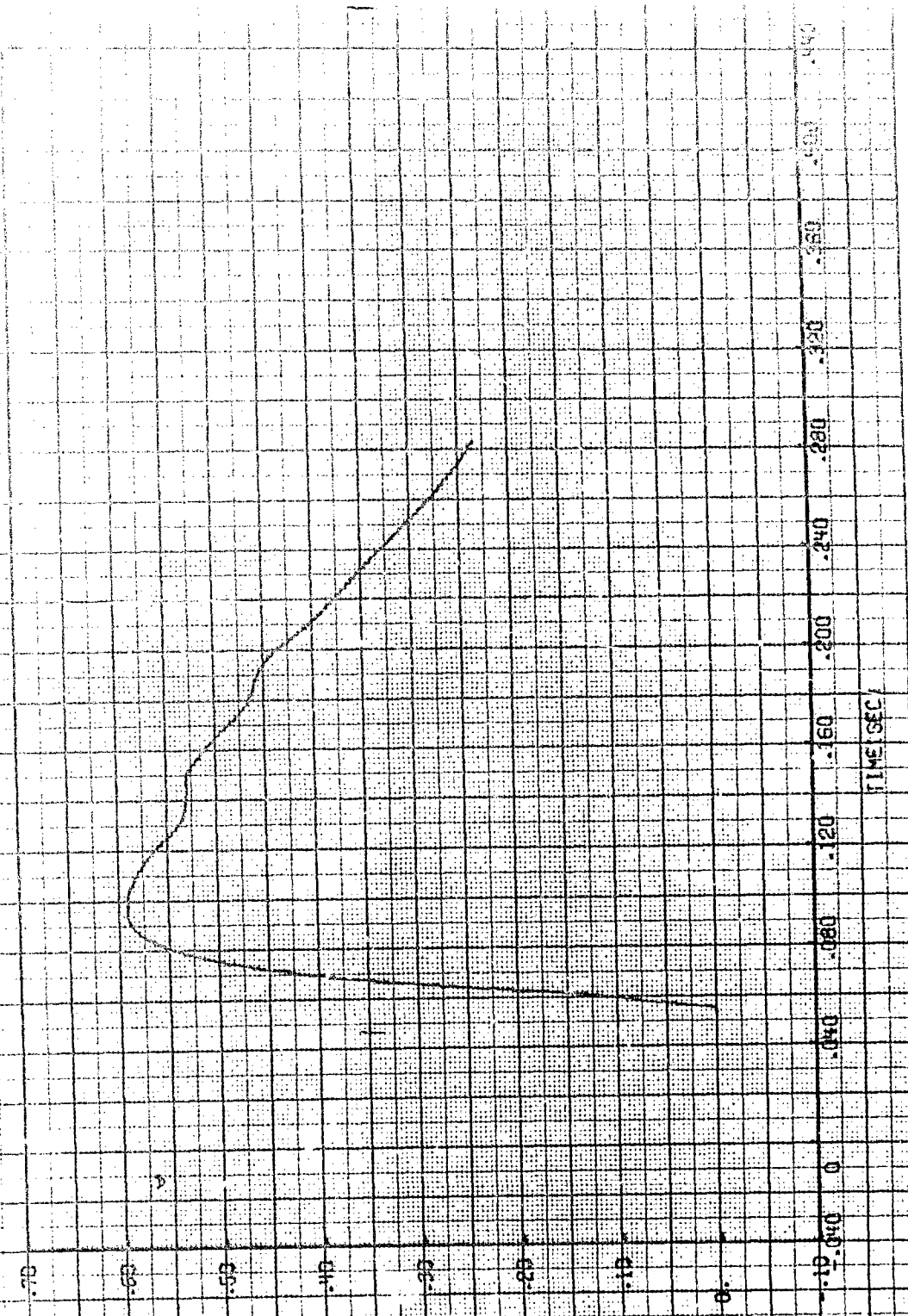
0.640

0.680

OVER PRESSURE (PSI)

311

OVER PRESSURE (INCHES) vs TIME (SECS)

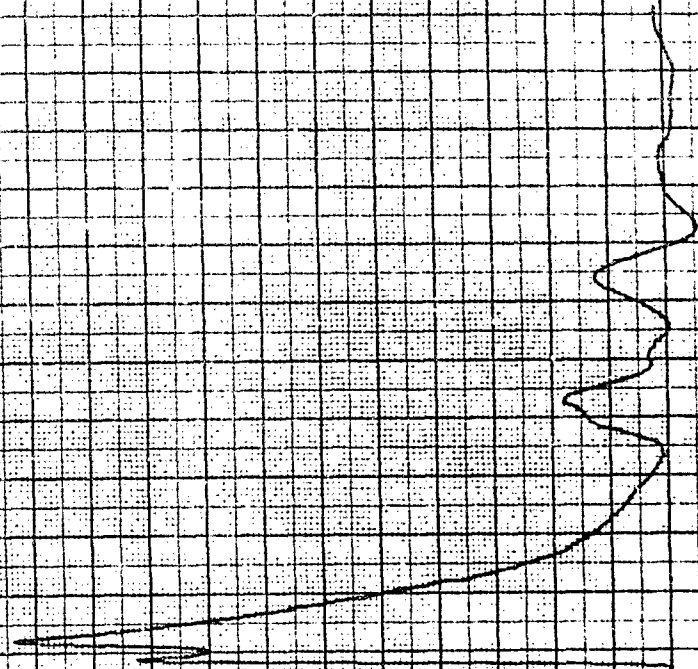


HORIZONTAL COMPONENT VELOCITY VS TIME STATION NUMBER 14

1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.

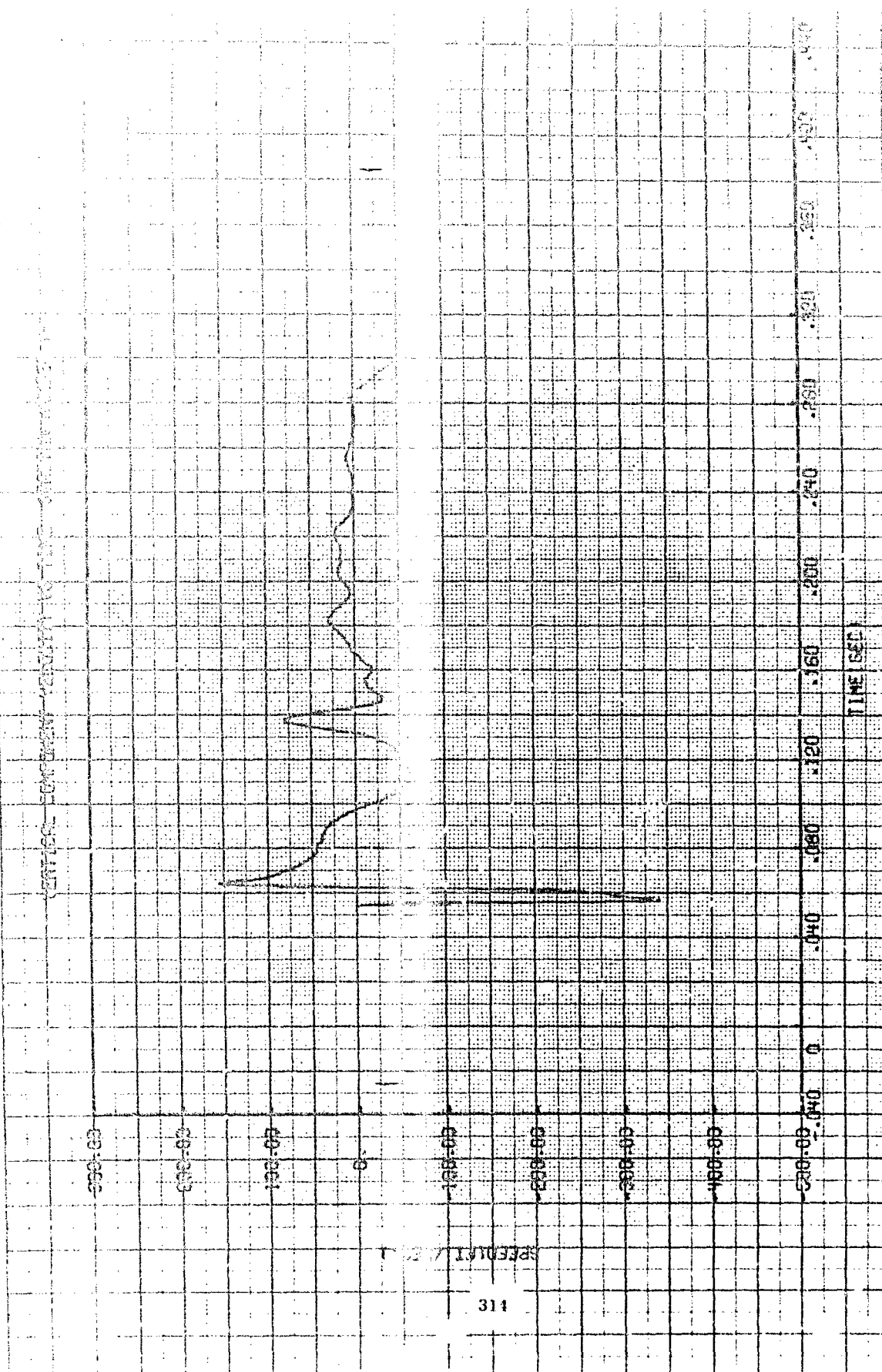
SPEED (FT / SEC.)

313

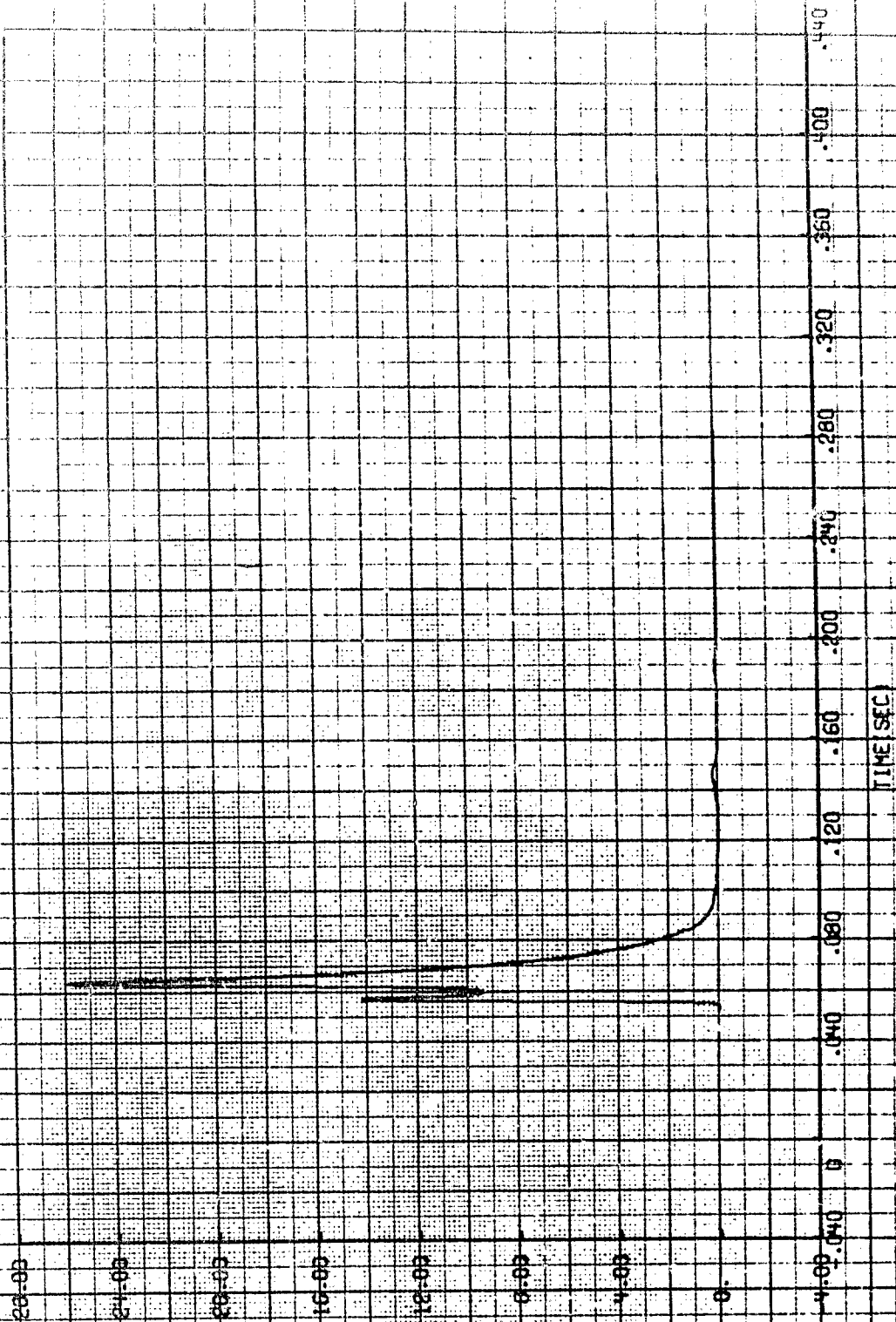


TIME (SEC)

0.040 0 0.080 0.120 0.160 0.200 0.240 0.280 0.320 0.360 0.400 0.440



HORIZONTAL DYNAMIC PRESSURE VS TIME STATION NUMBER 14



DYNAMIC PRESSURE (PSI)

TIME (SEC)

VENTILATOR DYNAMIC PRESSURE VS TIME - STATION NUMBER 14

1.00

.80

.60

.40

.20

.00

-.20

-.40

-.60

TIME (SEC)

.000

.040

.080

.120

.160

.200

.240

.280

.320

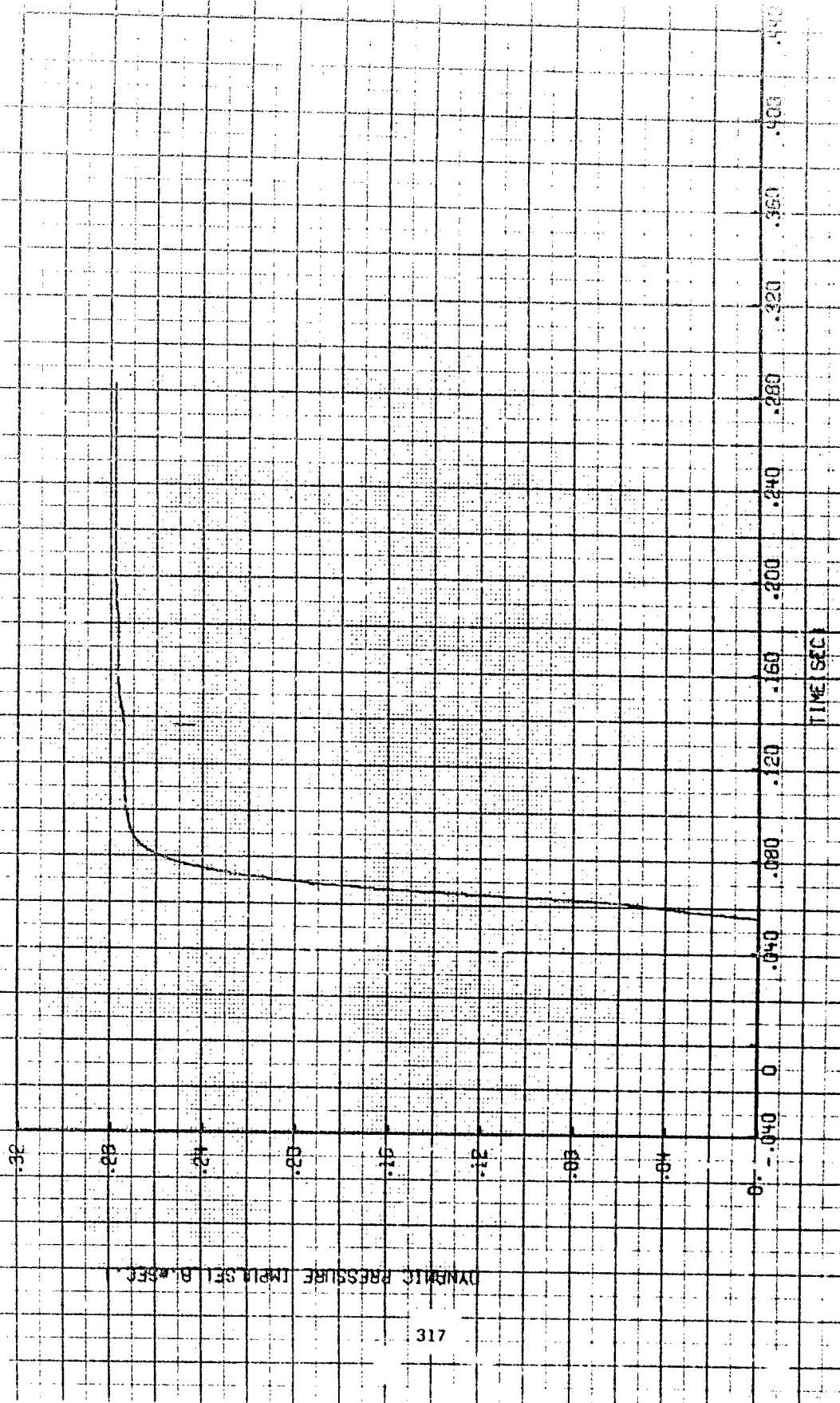
.360

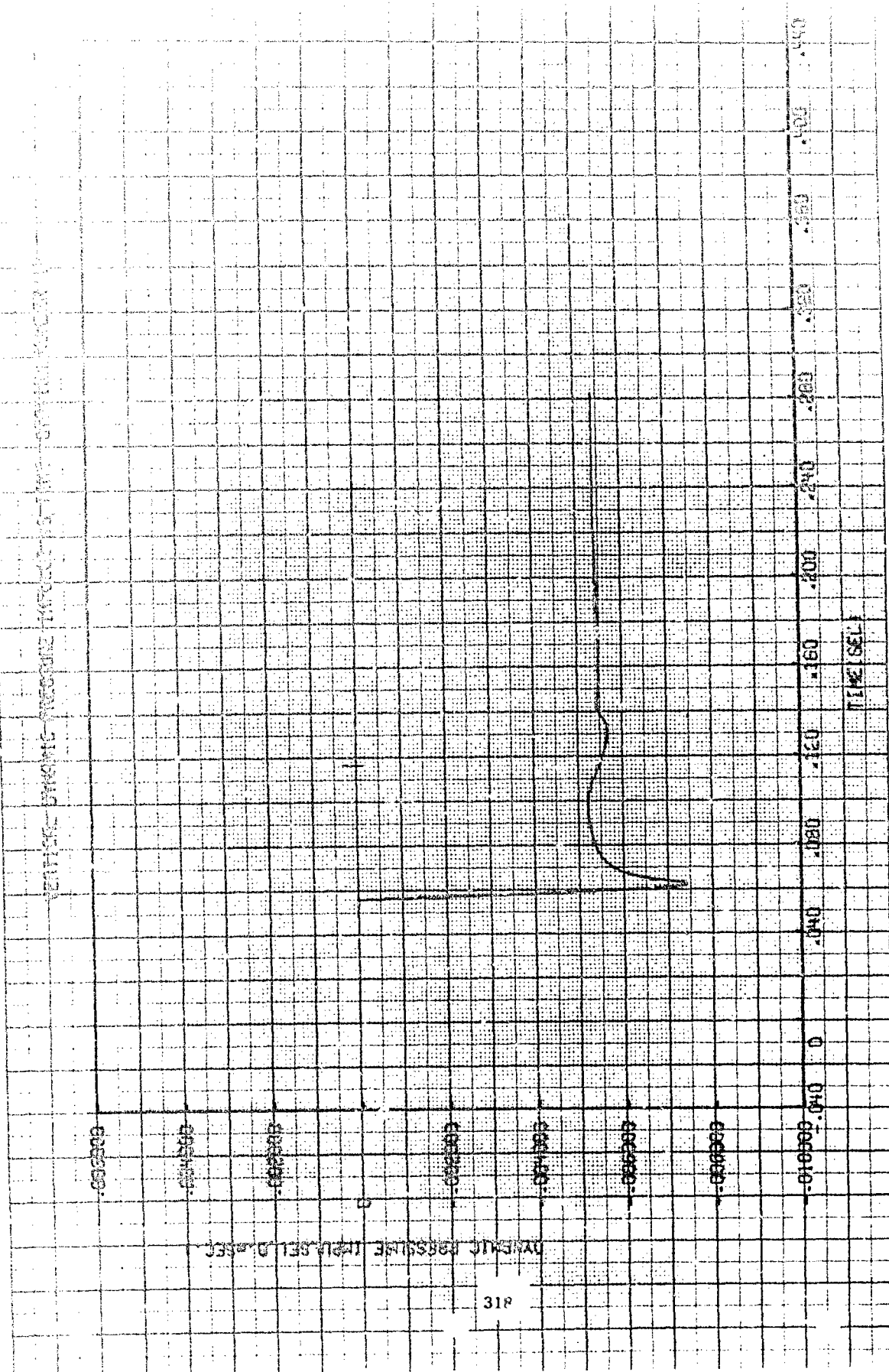
.400

.440

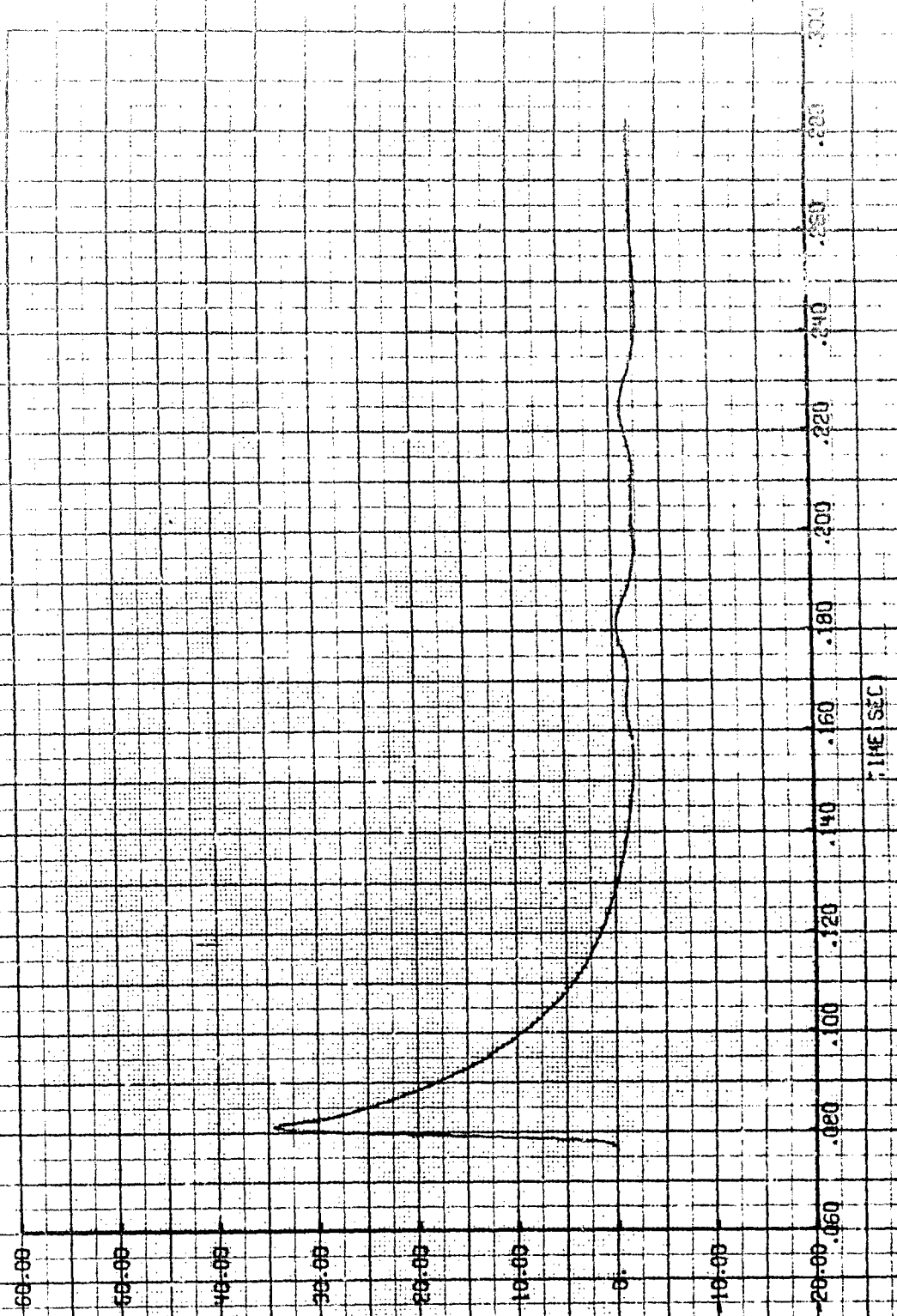
DYNAMIC PRESSURE (PSI)

HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME - STATION NUMBER 14





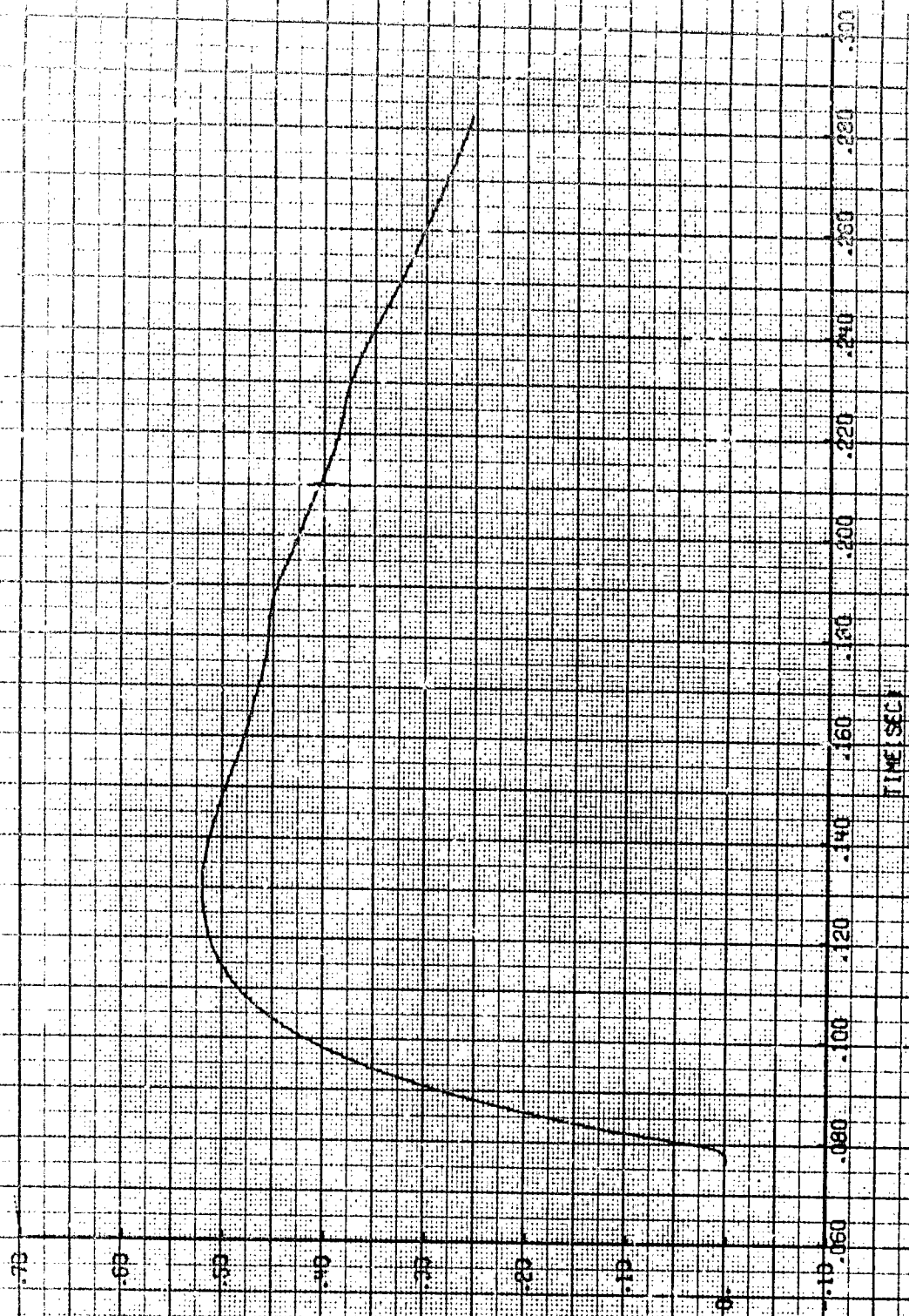
OVER PRESSURE VS TIME STATION NUMBER 10



OVER PRESSURE (PSI)

TIME (SEC)

OVERPRESSURE IMPULSE VS TIME STATION NUMBER 15



OVERPRESSURE IMPULSE (INCHES L.B./SEC.)

STATIONARY COMPONENT VELOCITY VS TIME - STATIONARY WIND

1400.00

1200.00

1000.00

800.00

600.00

400.00

200.00

0.

-200.00

.060

.080

.100

.120

.140

.160

.180

.200

.220

.240

.260

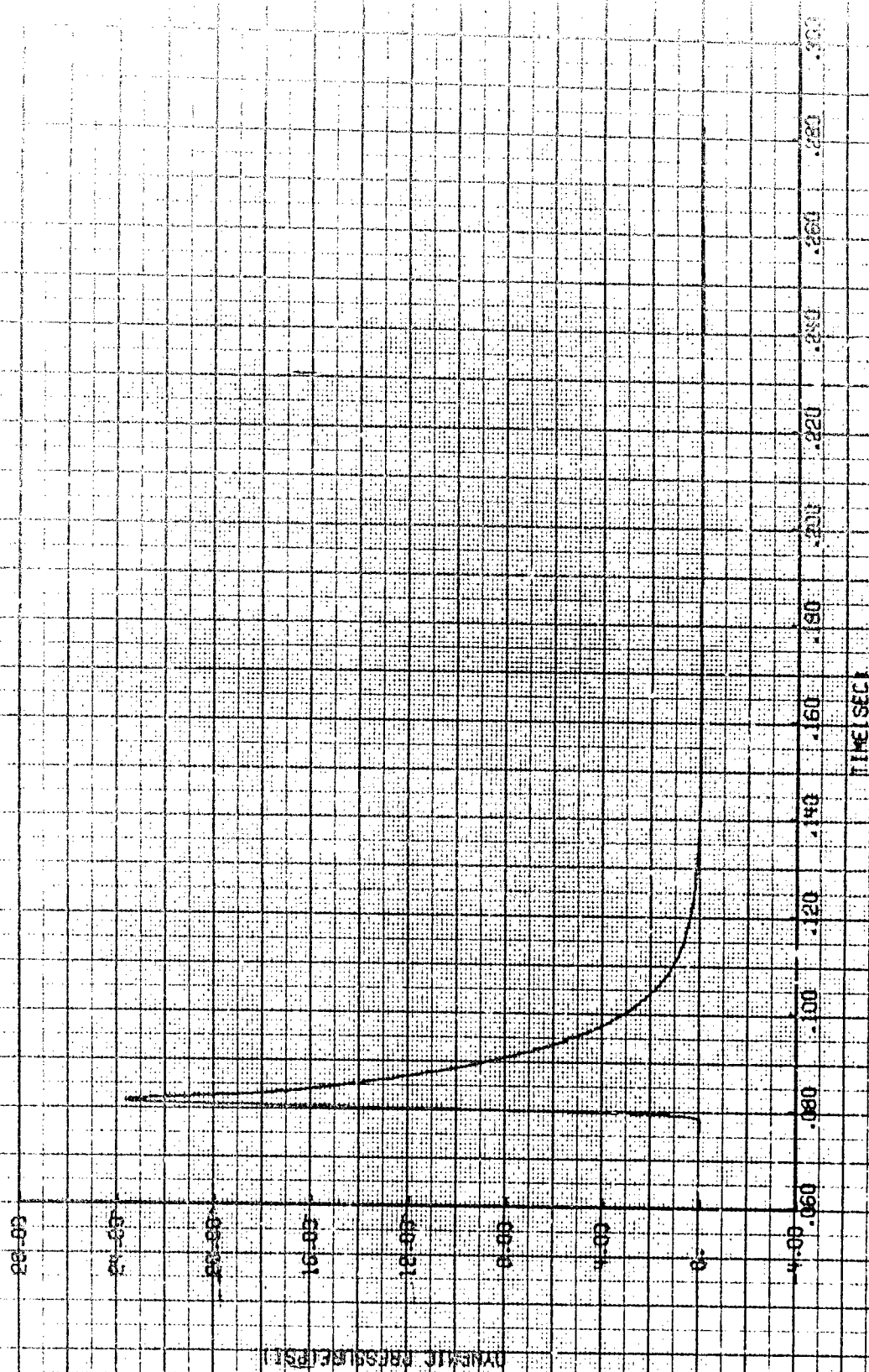
.280

.300

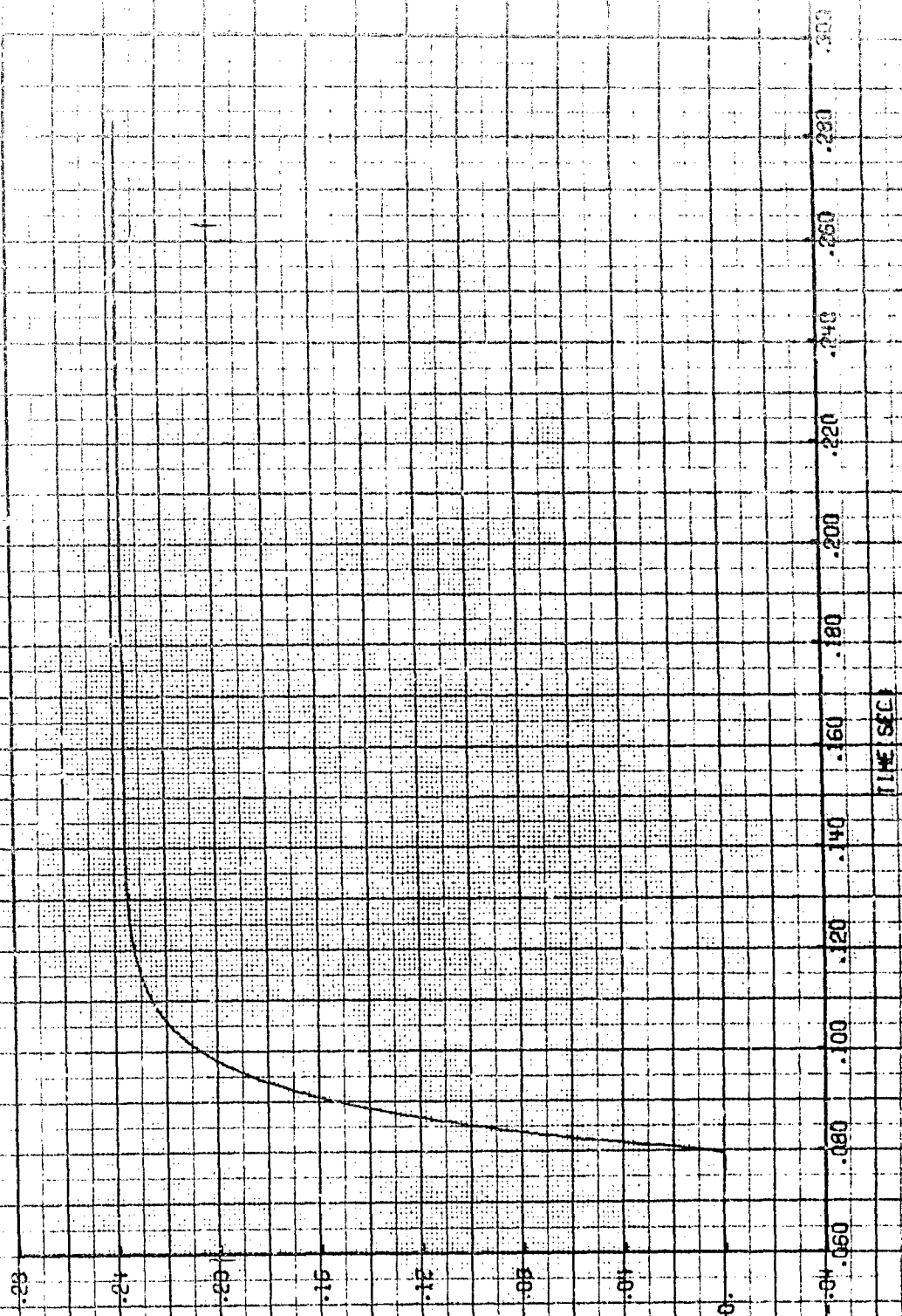
TIME (SEC)

SPEED (FT/SEC)

WATERGATE DYNAMIC PRESSURE VS TIME - CONTINUED



HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME - STATION NUMBER 18



DYNAMIC PRESSURE IMPULSE LB-SEC

OVER PRESSURE VS TIME - CATHOLIC NUMBER 11

28-03

24-03

20-03

16-03

12-03

8-03

4-03

0-

4-03

0

040

080

120

160

200

240

280

320

360

400

440

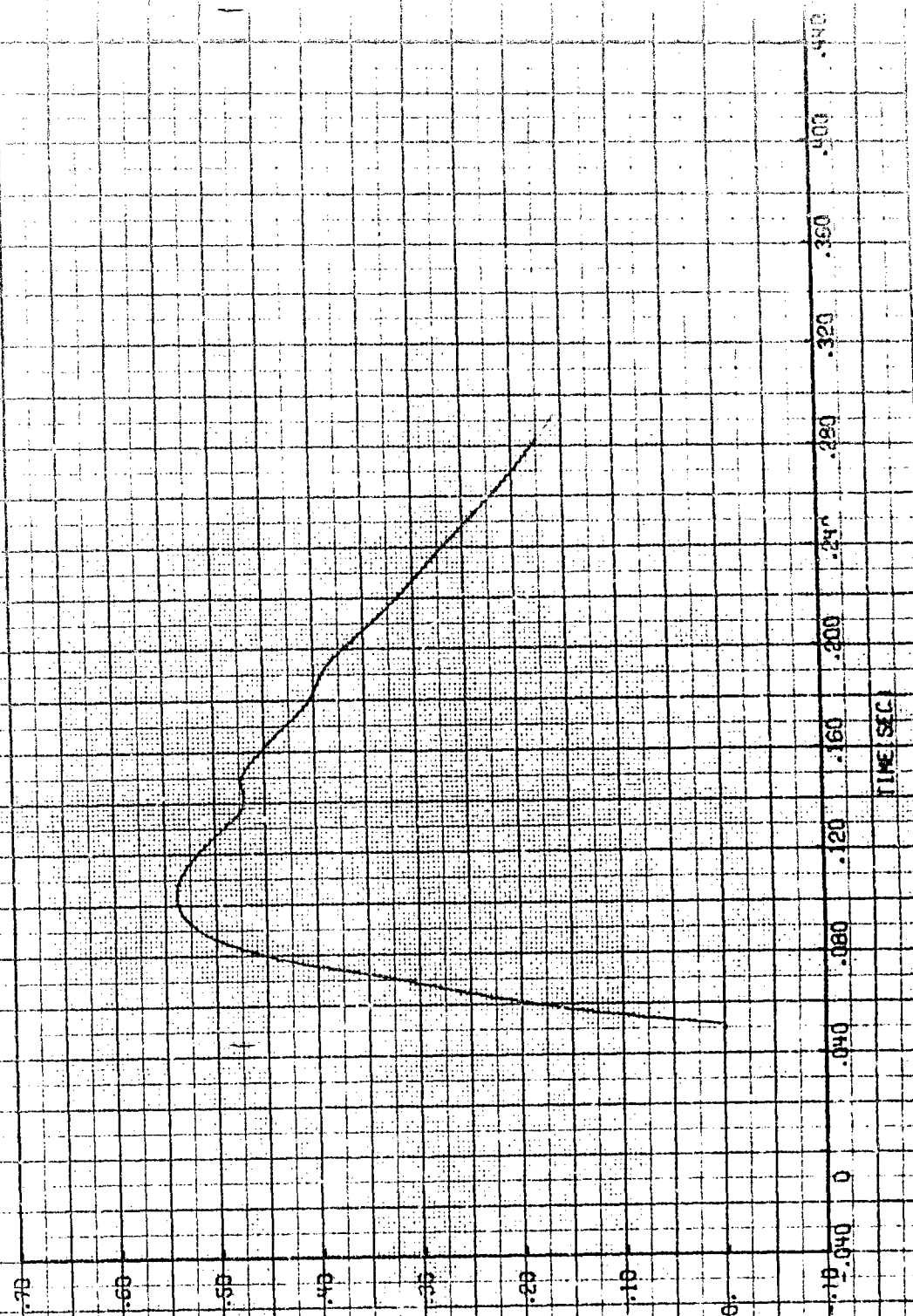
480

520

OVER PRESSURE (PSI)

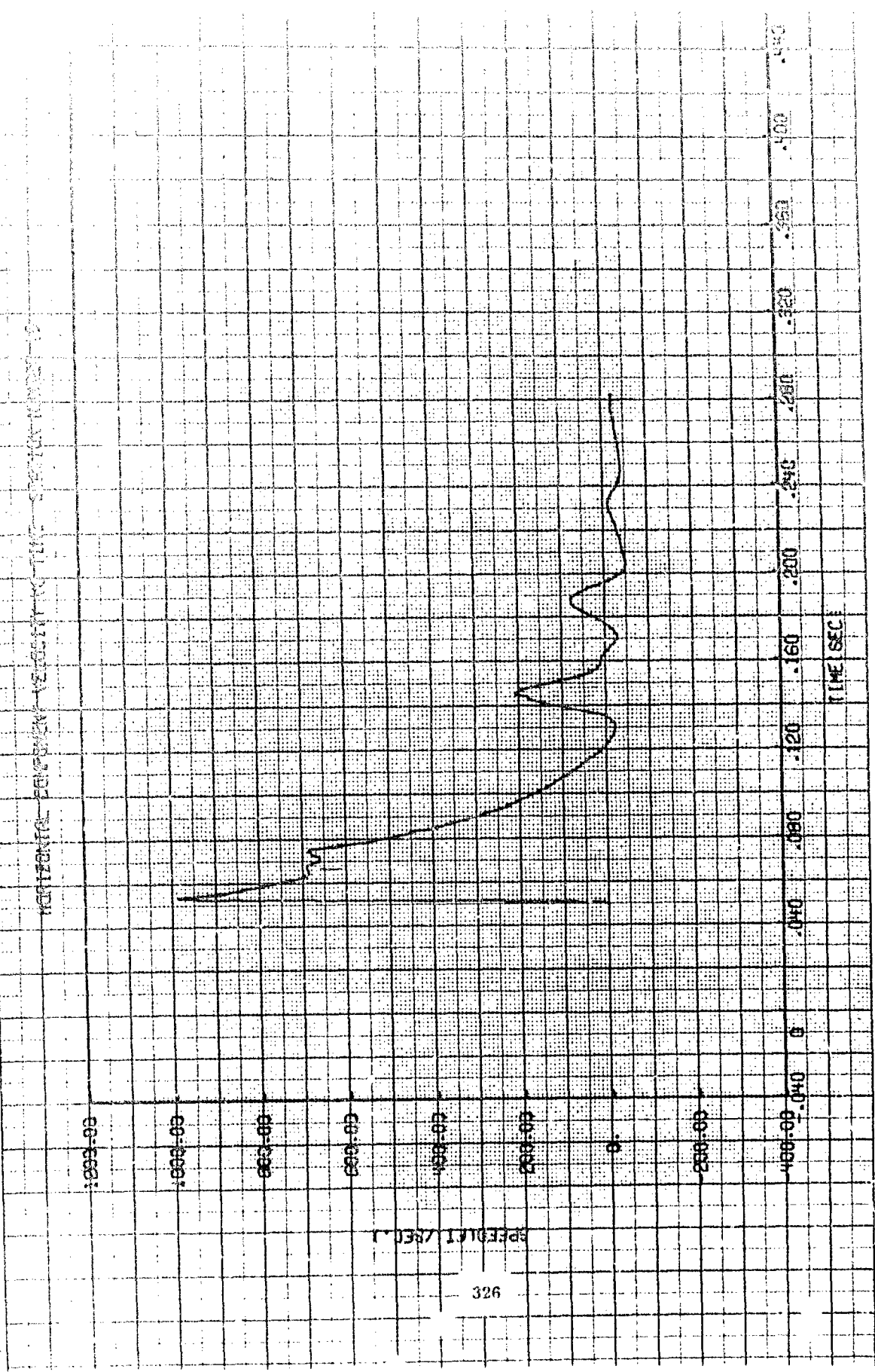
TIME (SEC)

OVER PRESSURE IMPULSE VS TIME - CRITICAL UNDER 10



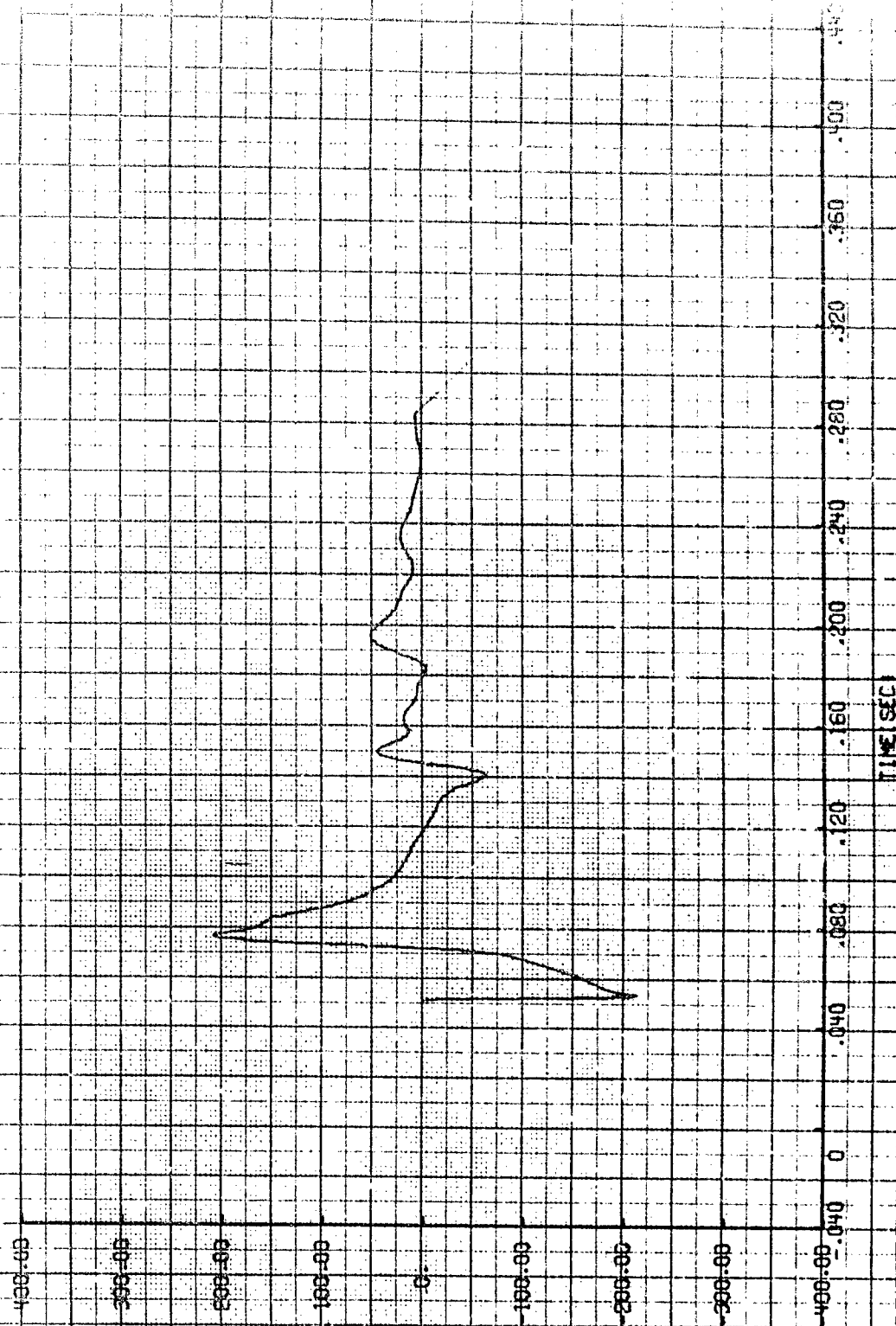
OVER PRESSURE IMPULSE (L.B./SEC.)

TIME (SEC)

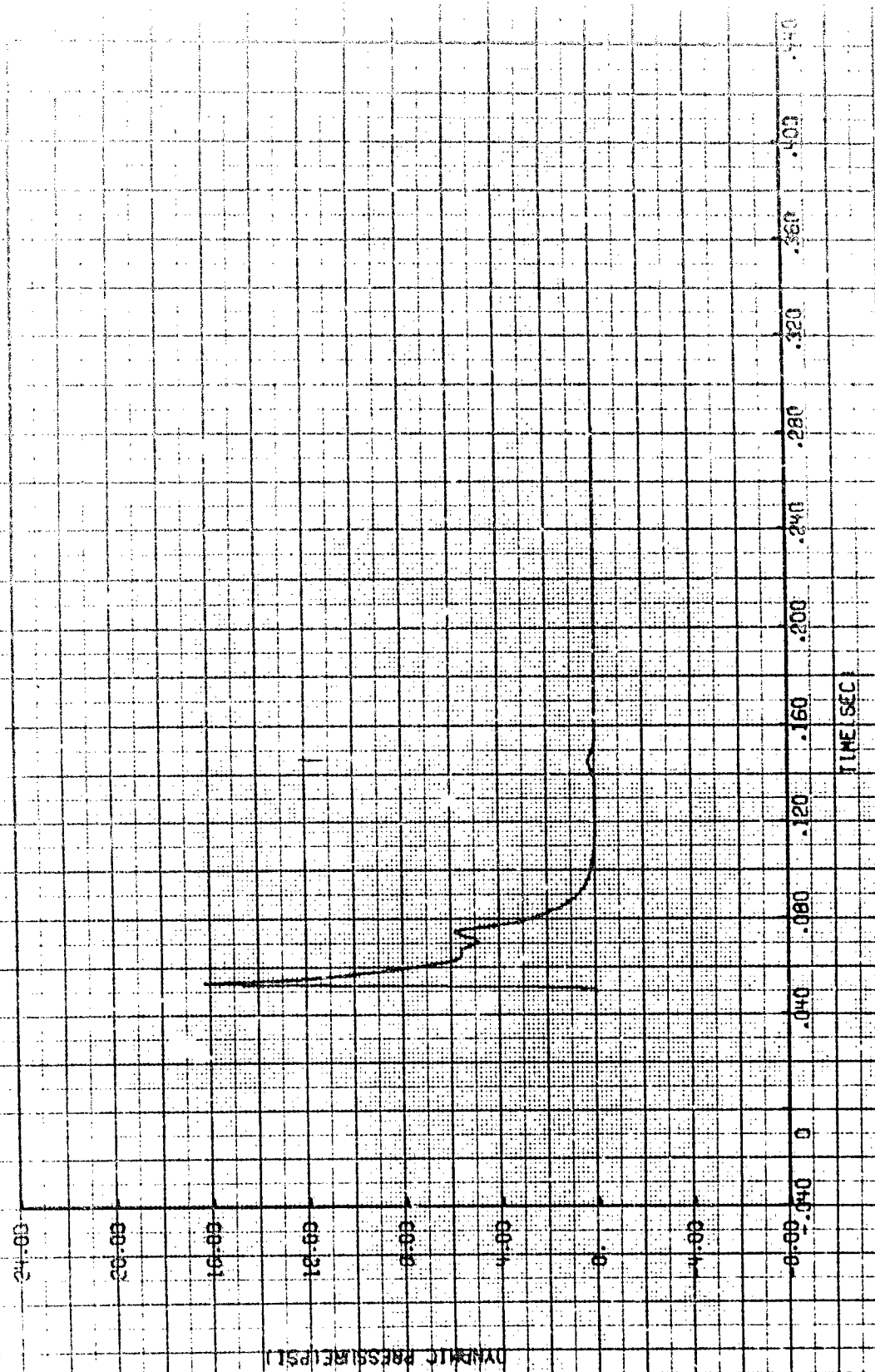


SPECTRUM / REF. 1

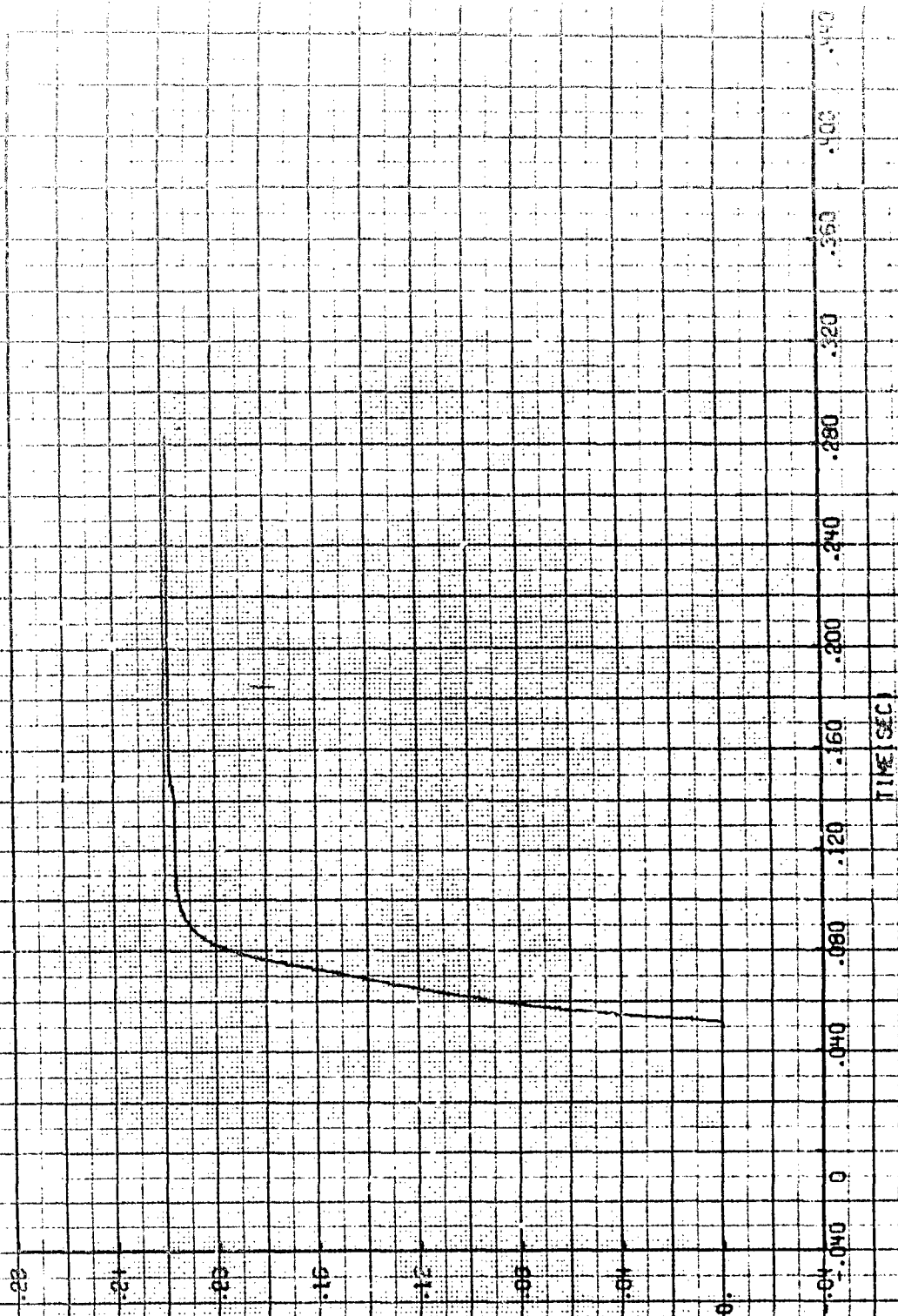
VERTICAL COMPONENT VELOCITY VS TIME STATION NUMBER 10



HORIZONTAL DYNAMIC PRESSURE VS TIME (CONTINUED)

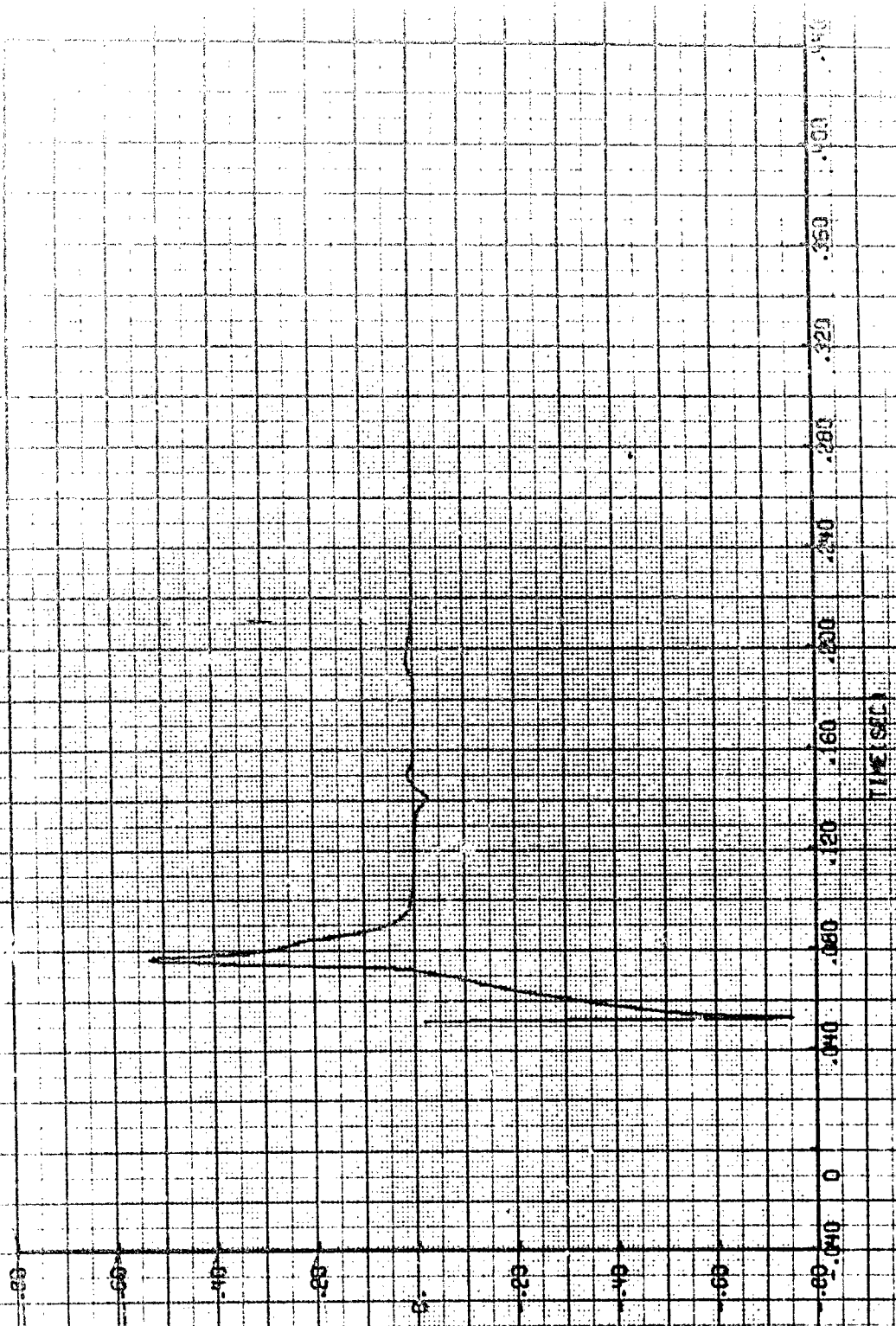


HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME STATION NUMBER 10



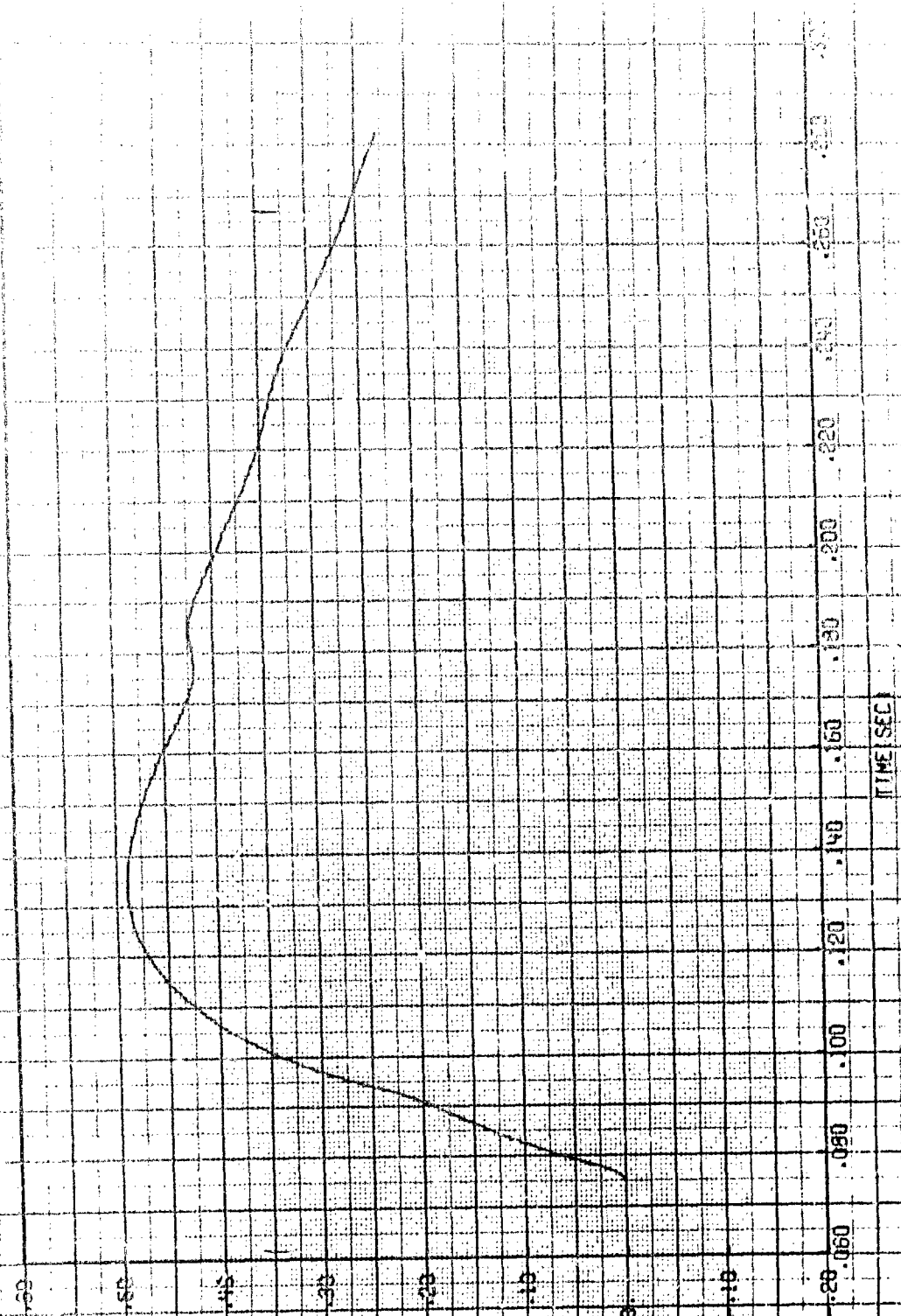
DYNAMIC PRESSURE IMPULSE, LBS./SQ. IN.

VERTICAL DYNAMIC PRESSURE VS TIME - STATION NUMBER 10



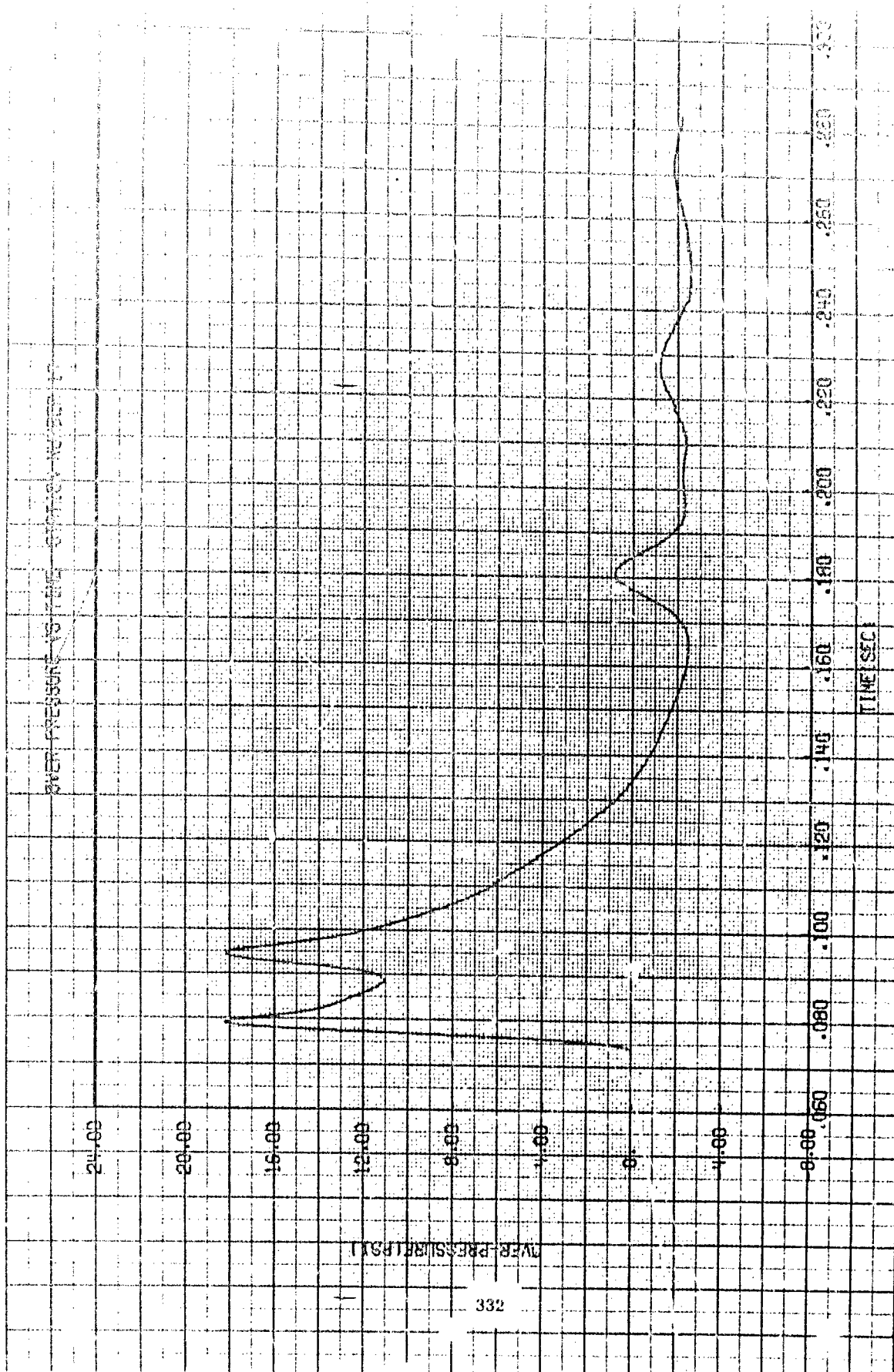
DYNAMIC PRESSURE (PSI)

OVER PRESSURE INFLUENCE TO THE CRYSTALLIZATION

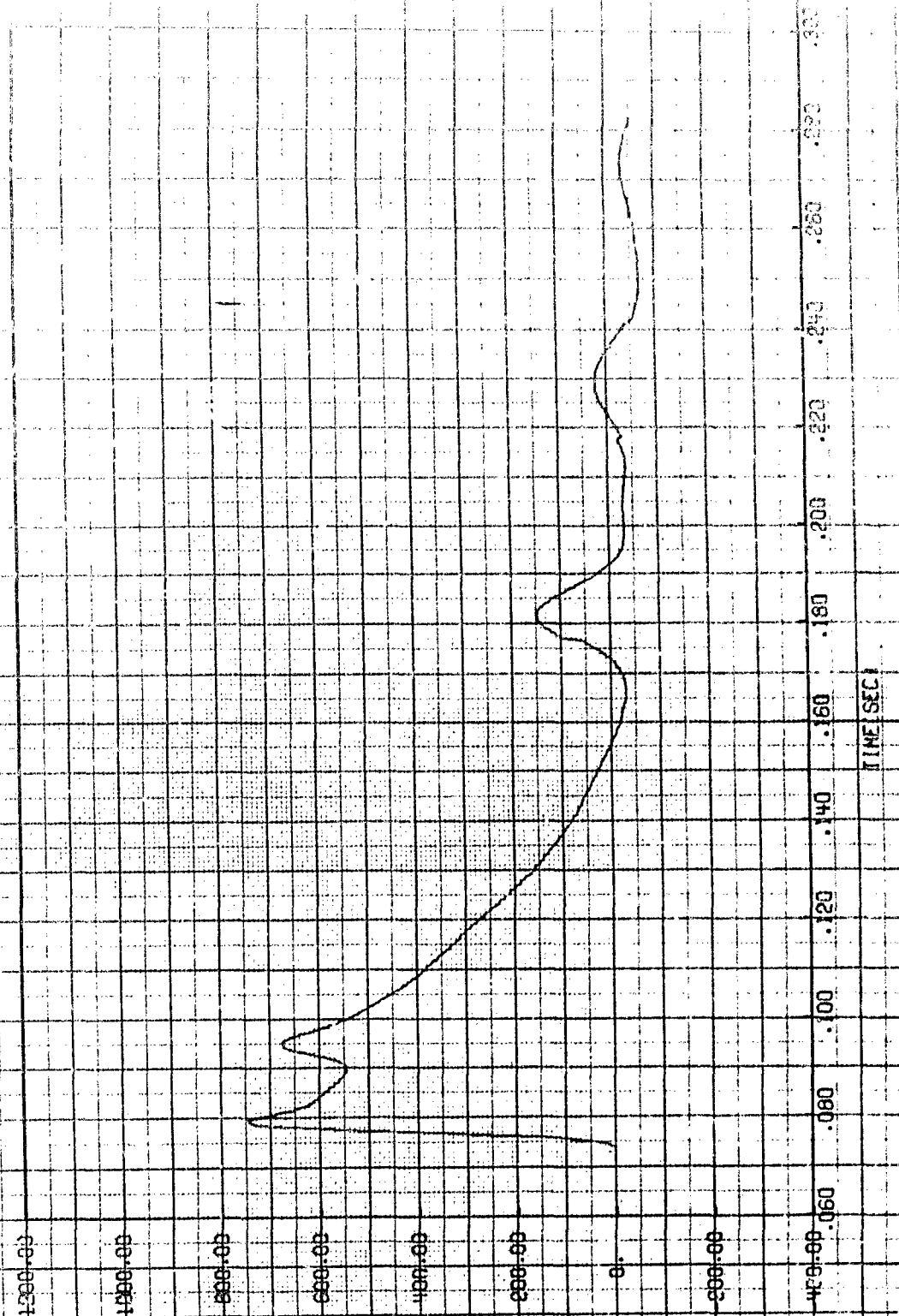


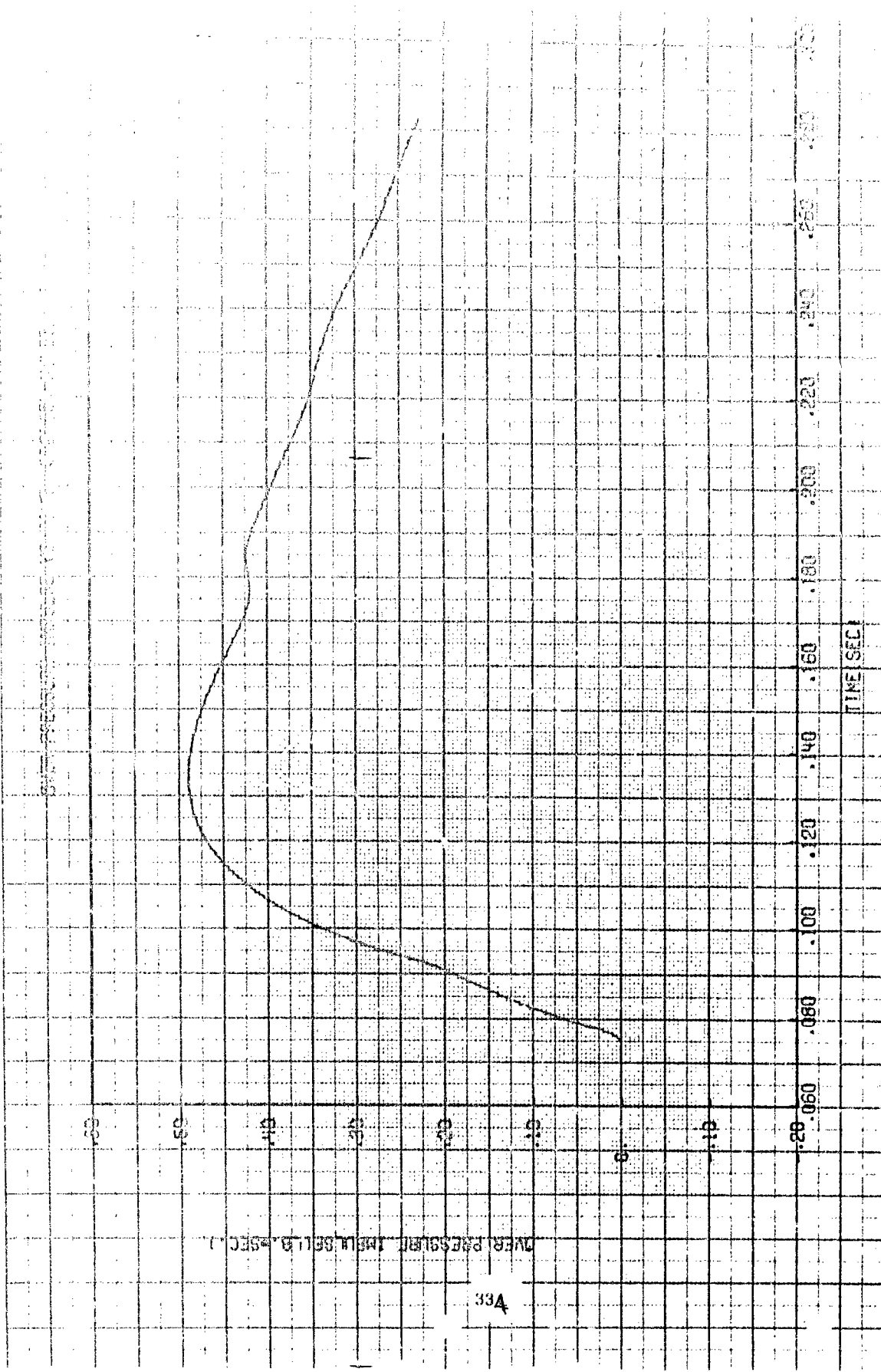
OVER PRESSURE (LB./SQ. IN.)

TIME (SEC)



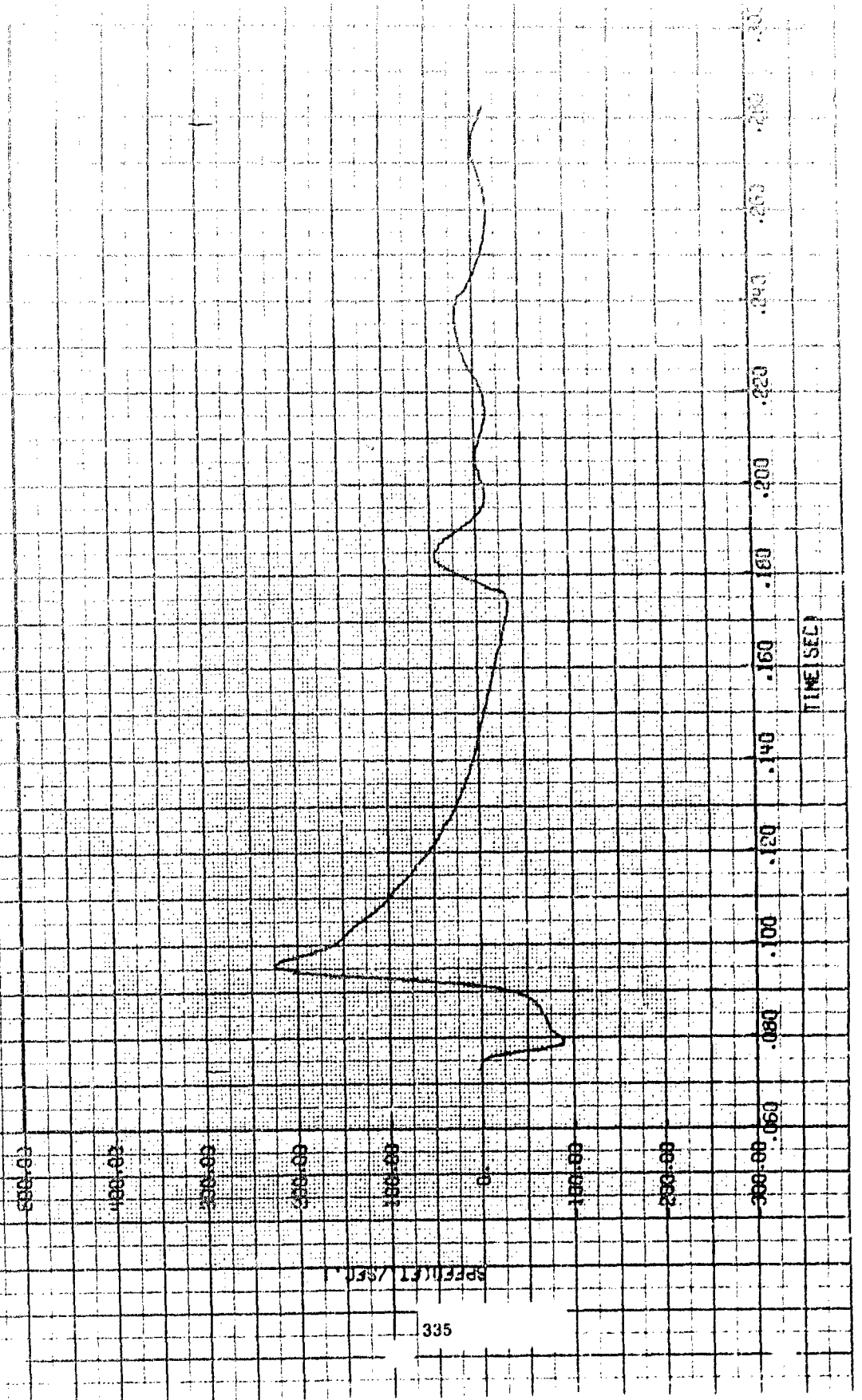
HORIZONTAL COMPONENT VELOCITY VS TIME STRIKING WHEEL 12





33A

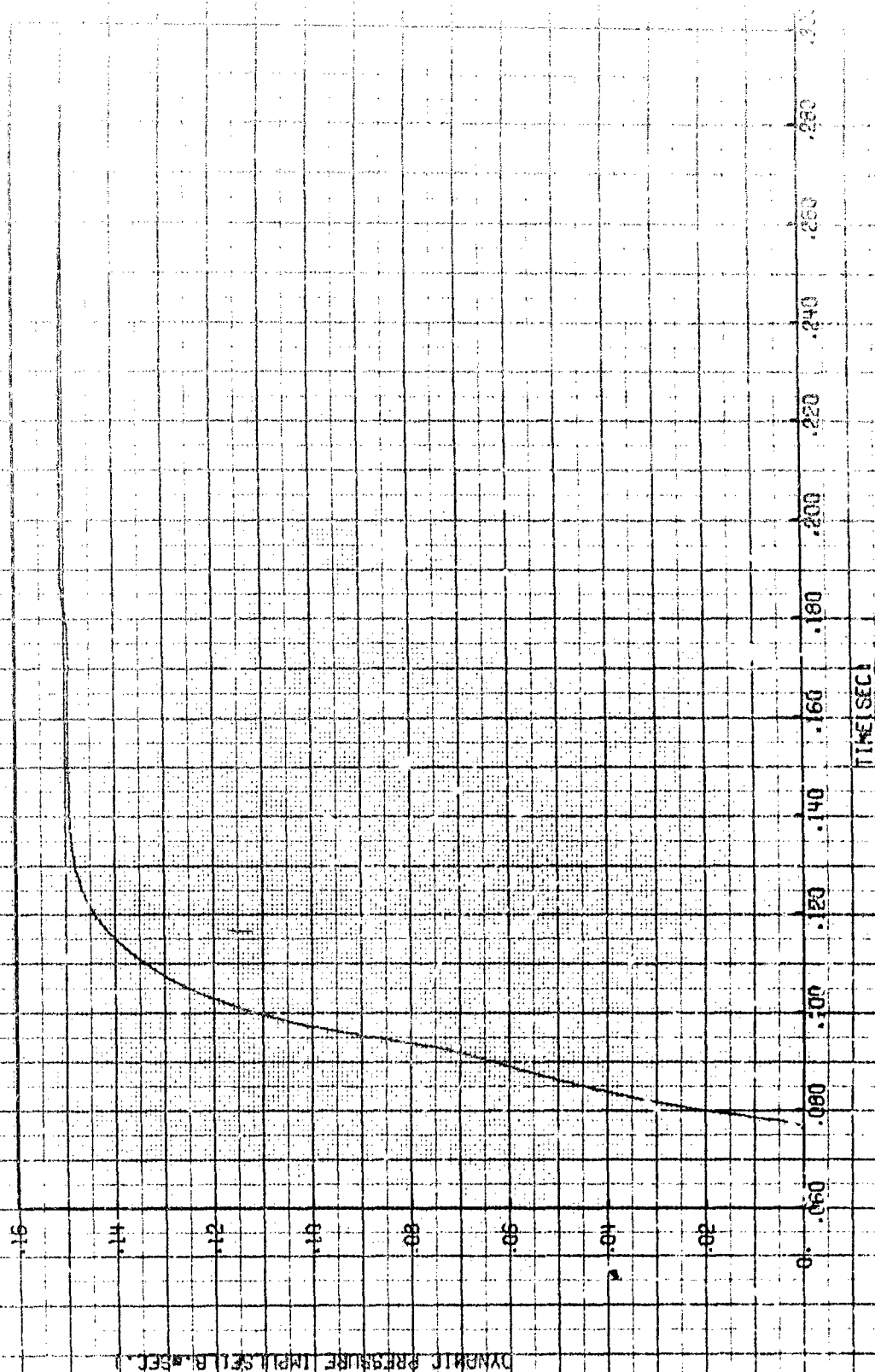
VERTICAL COMPONENT VELOCITY TIME CORRELATION



335

1

HORIZONTAL DYNAMIC PRESSURE PULSE VS TIME - STATION NUMBER 12



VERTICAL AND HORIZONTAL DISTANCE TO THE STATION CENTER

TIME SEC

00000 00100 00200 00300 00400 00500 00600 00700 00800 00900 01000 01100 01200 01300 01400 01500 01600 01700 01800 01900 02000 02100 02200 02300 02400 02500 02600 02700 02800 02900 03000

007000

006000

005000

004000

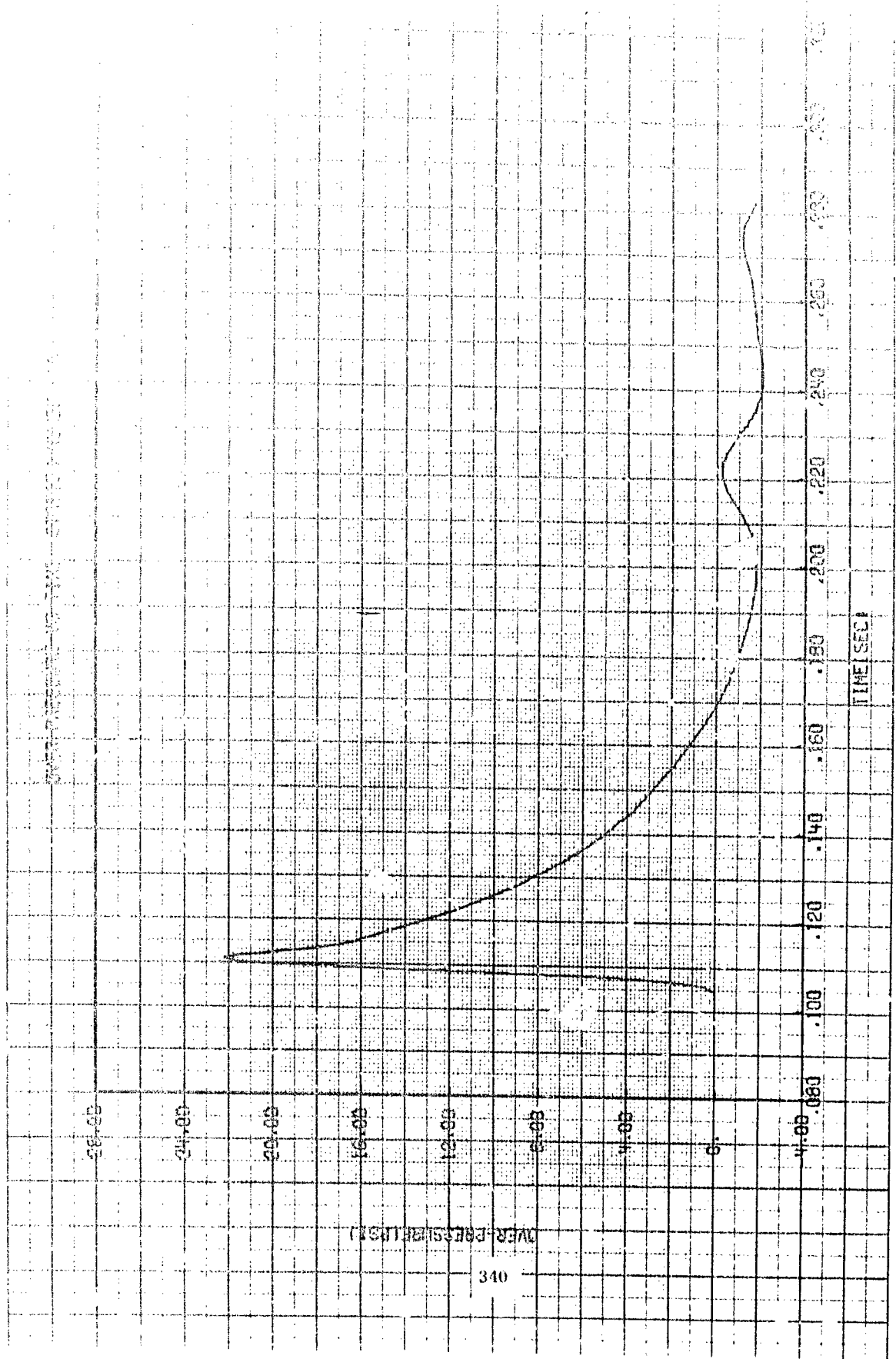
003000

002000

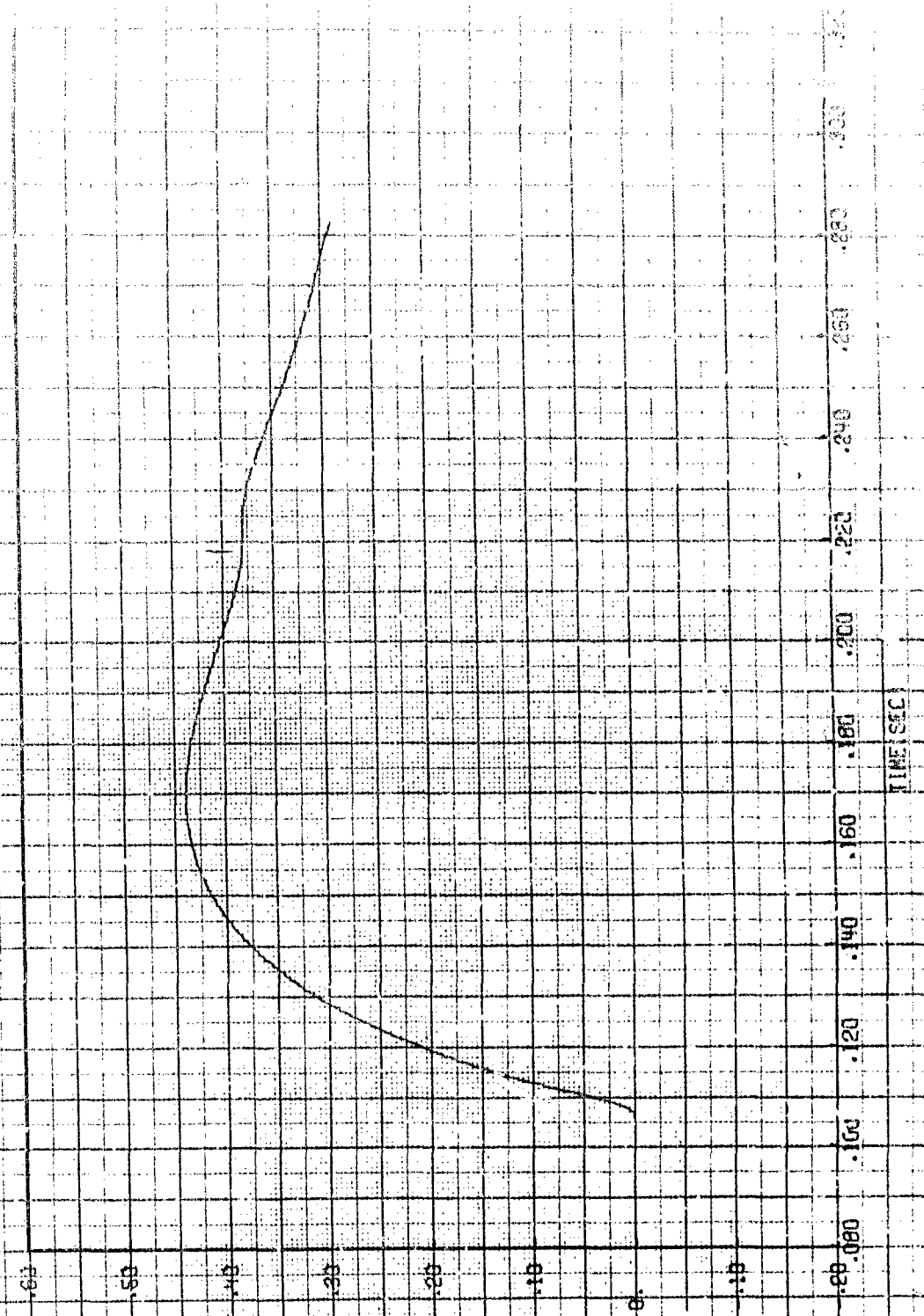
001000

0

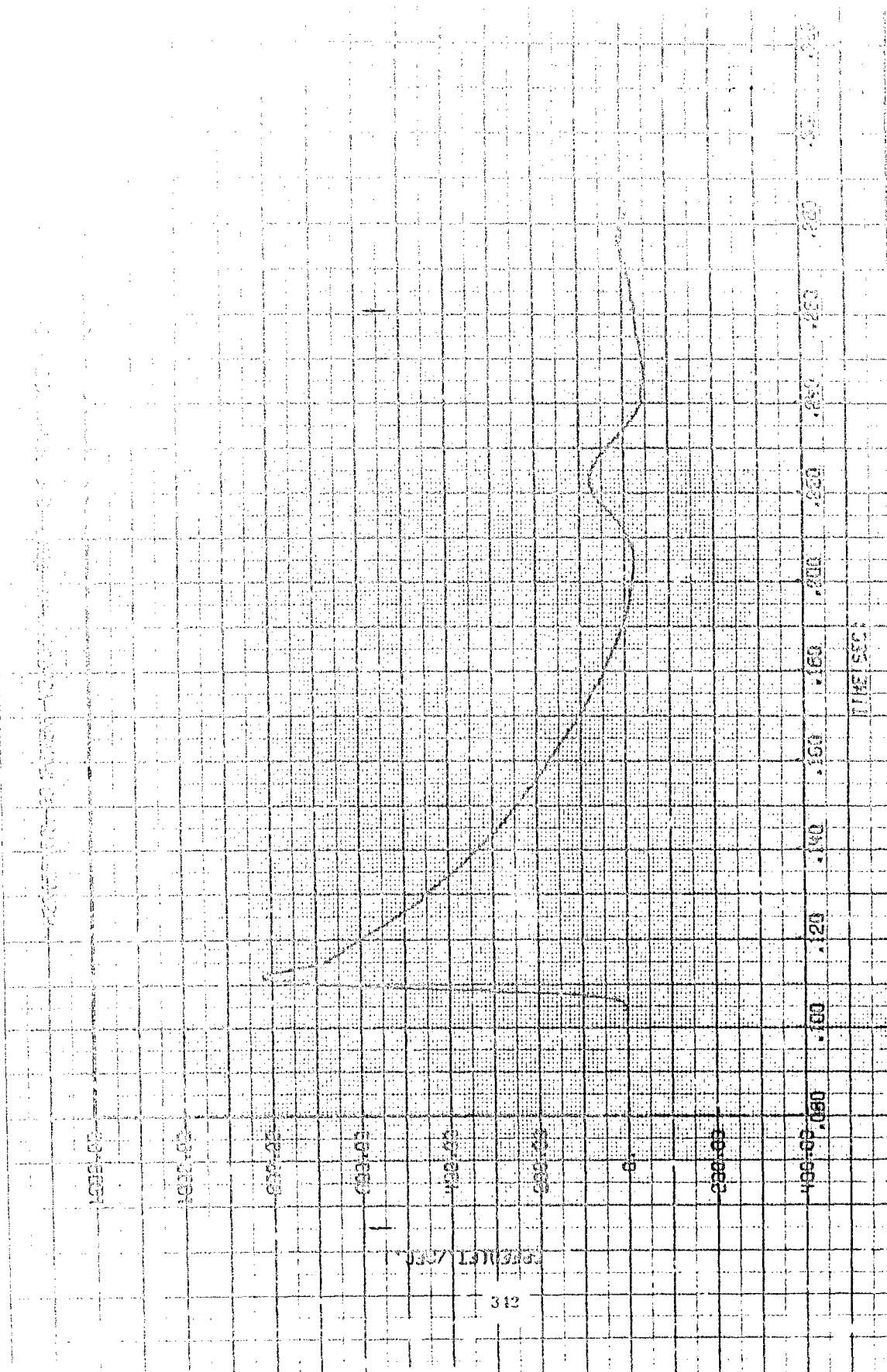
VERTICAL PRESSURE (IMPL. SEC. B. SEC.)



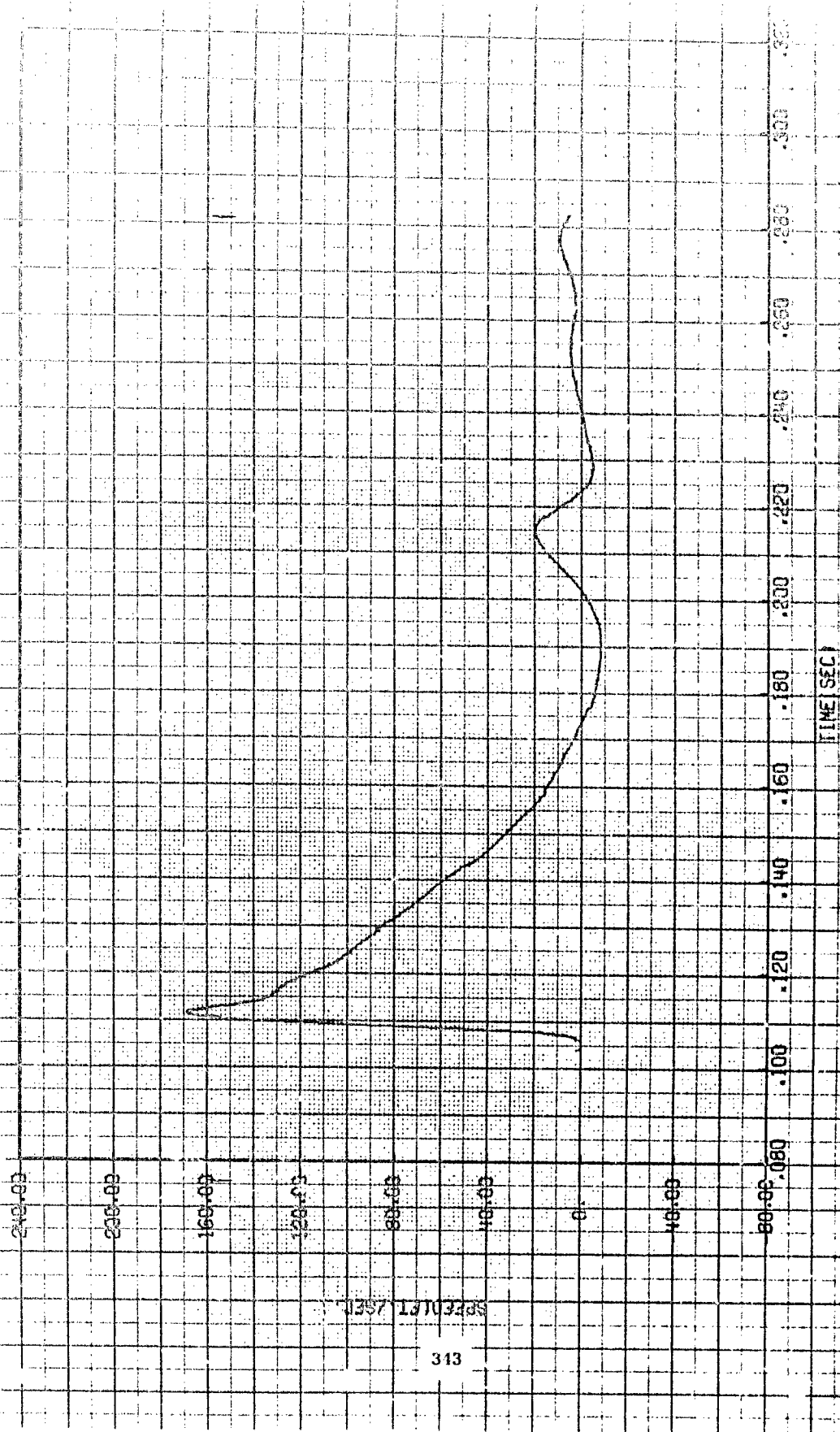
OVER PRESSURE (INCHES) VS TIME (SECONDS)



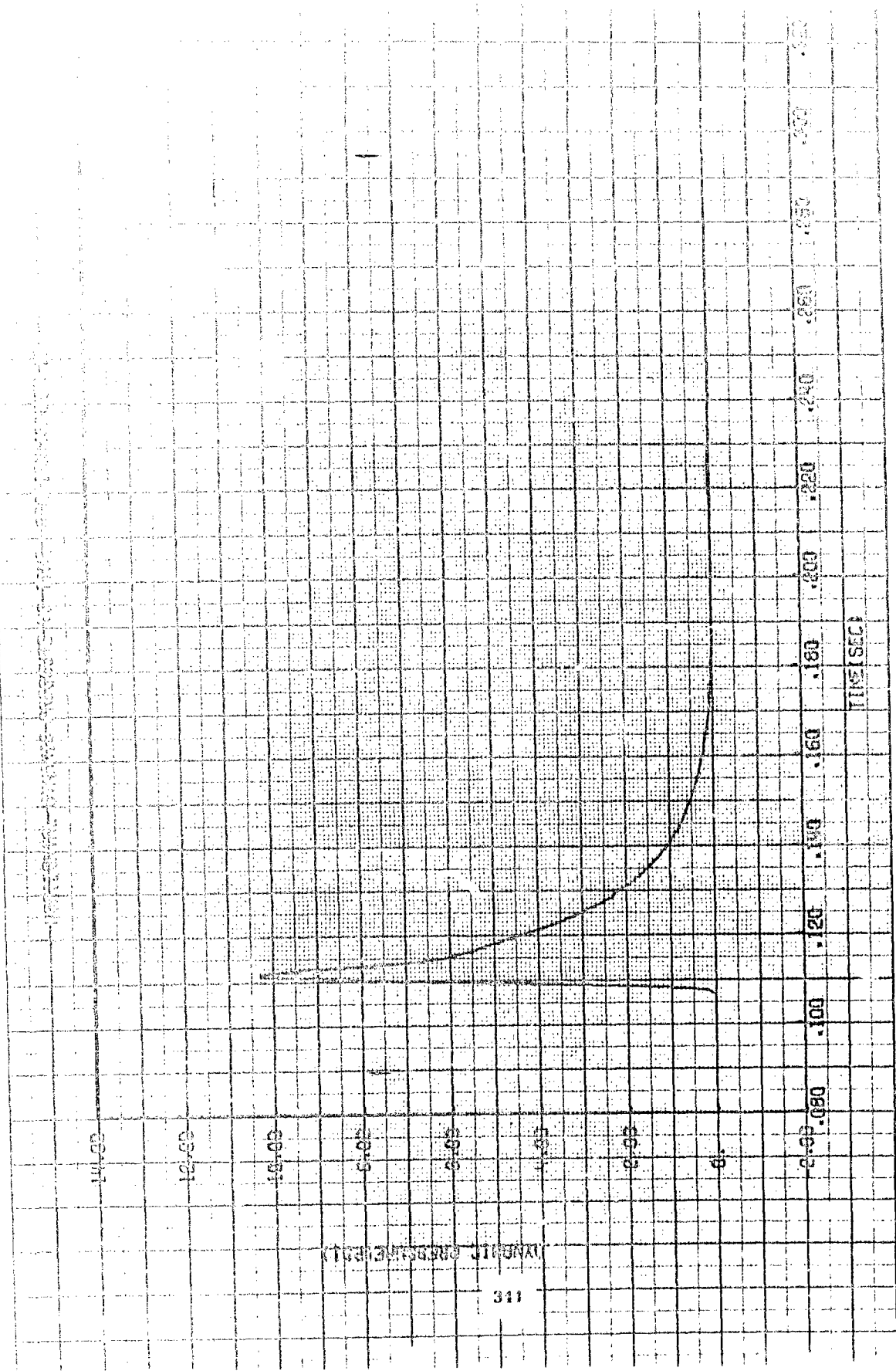
OVER PRESSURE (INCHES) VS TIME (SECONDS)



VENTURE SCIENCE - VENTURE SCIENCE - THE SCIENCE OF VENTURE

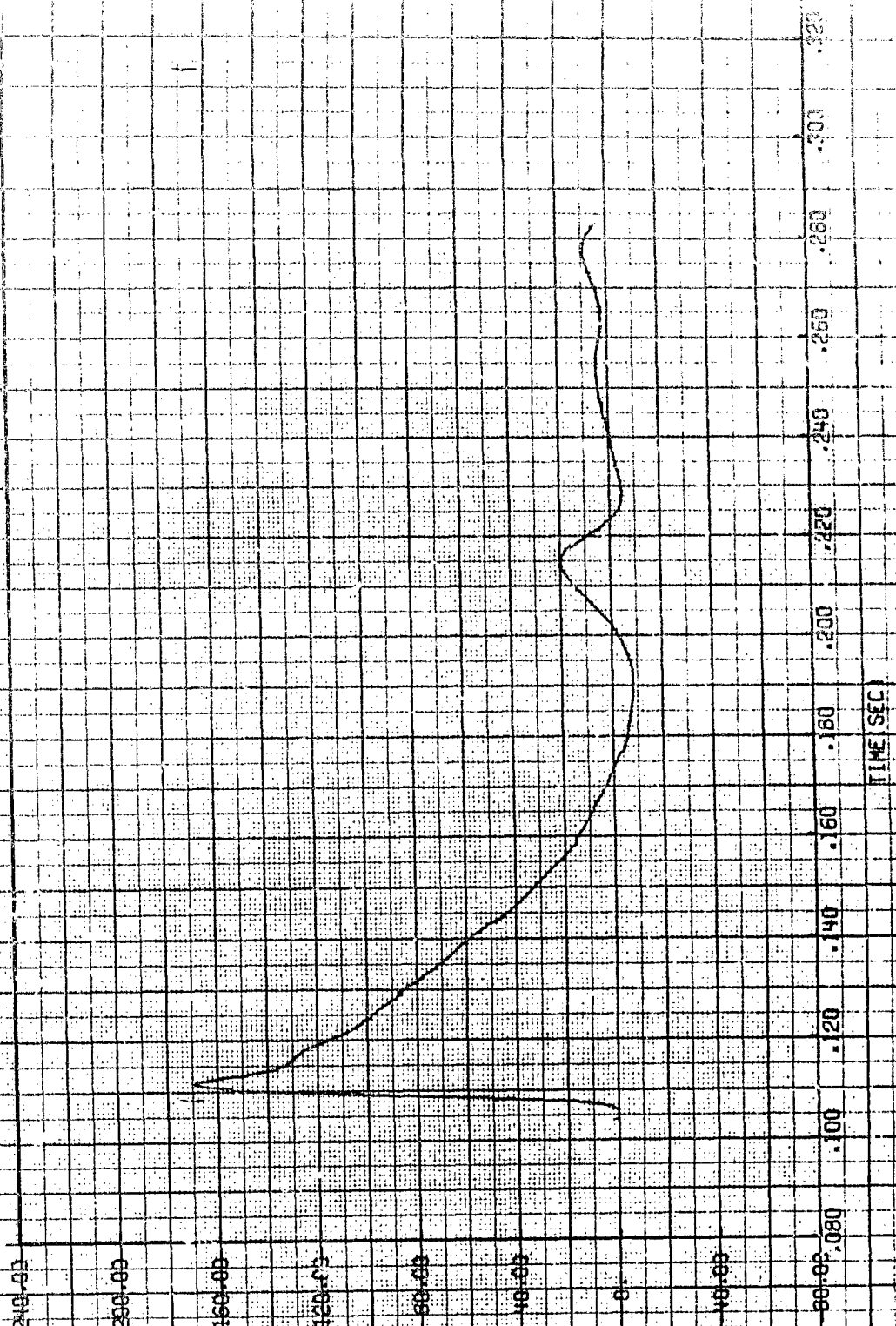


SPD (FT/SEC)

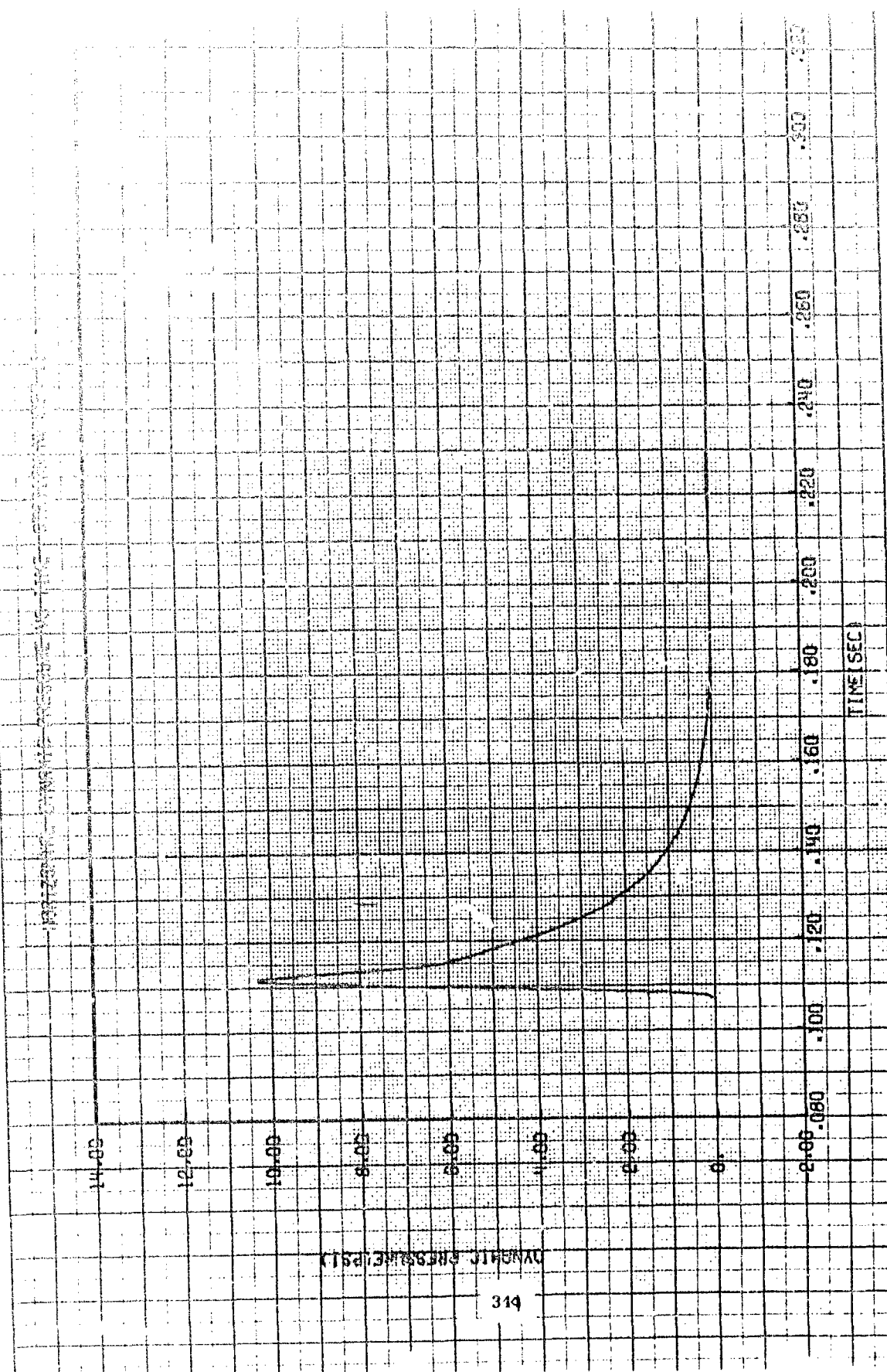


(10313113090 3110311)

VERTICAL COMPONENT VELOCITY VS TIME - SHOTGUN-KRUGER-13



57 13103233



1521377863HS J140N140

VERTICAL SHOCK PRESSURE VS TIME - CHRYSLER

60

50

40

30

20

10

0

-10

-20

0.080

0.100

0.120

0.140

0.160

0.180

0.200

0.220

0.240

0.260

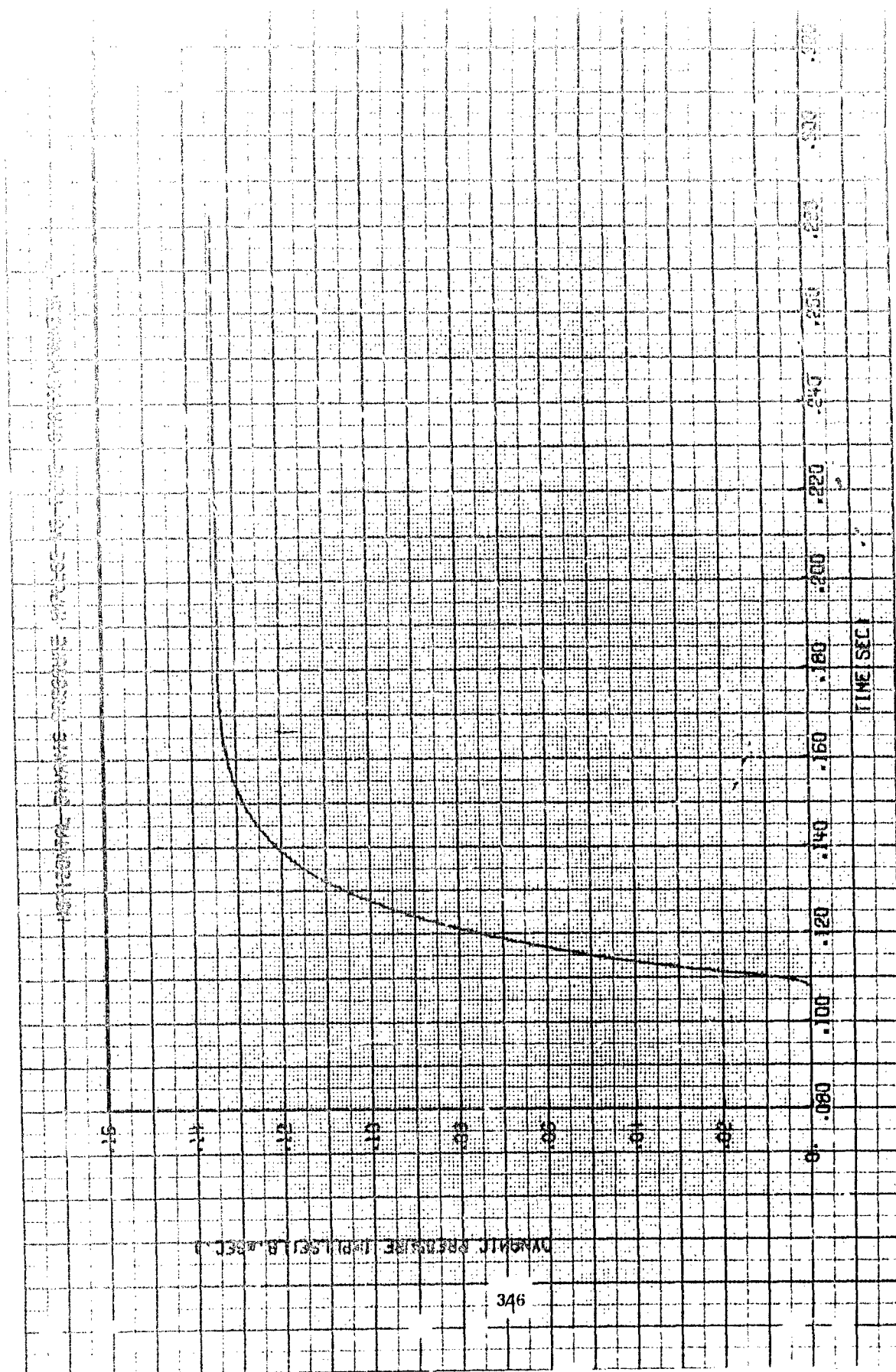
0.280

0.300

0.320

TIME (SEC)

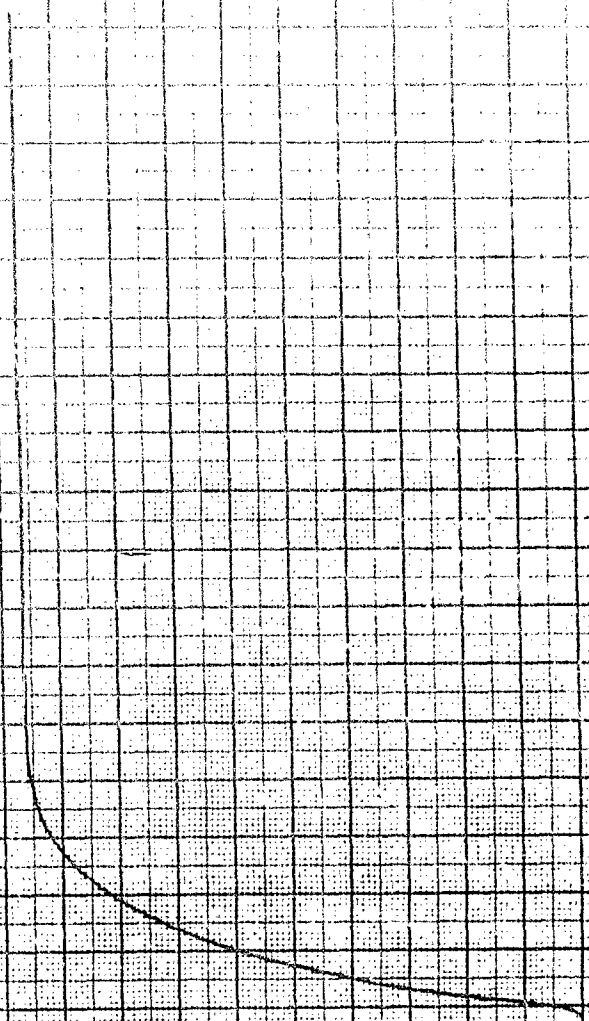
DYNAMIC PRESSURE (PSI)



VERTICAL IMPACT PRESSURE IMPULSE (LBS.-SEC.)

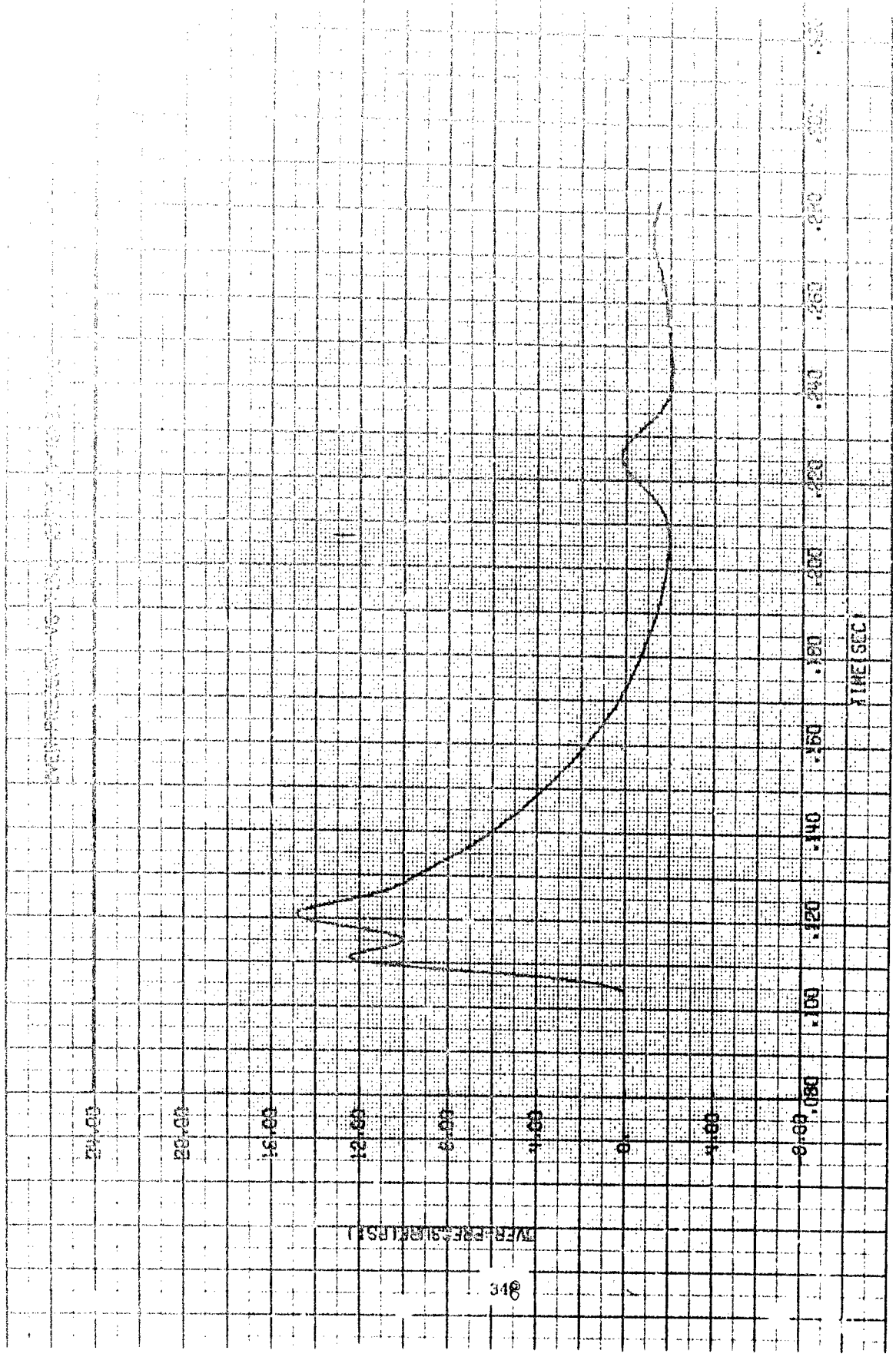
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DYNAMIC PRESSURE IMPULSE (LBS.-SEC.)



0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000

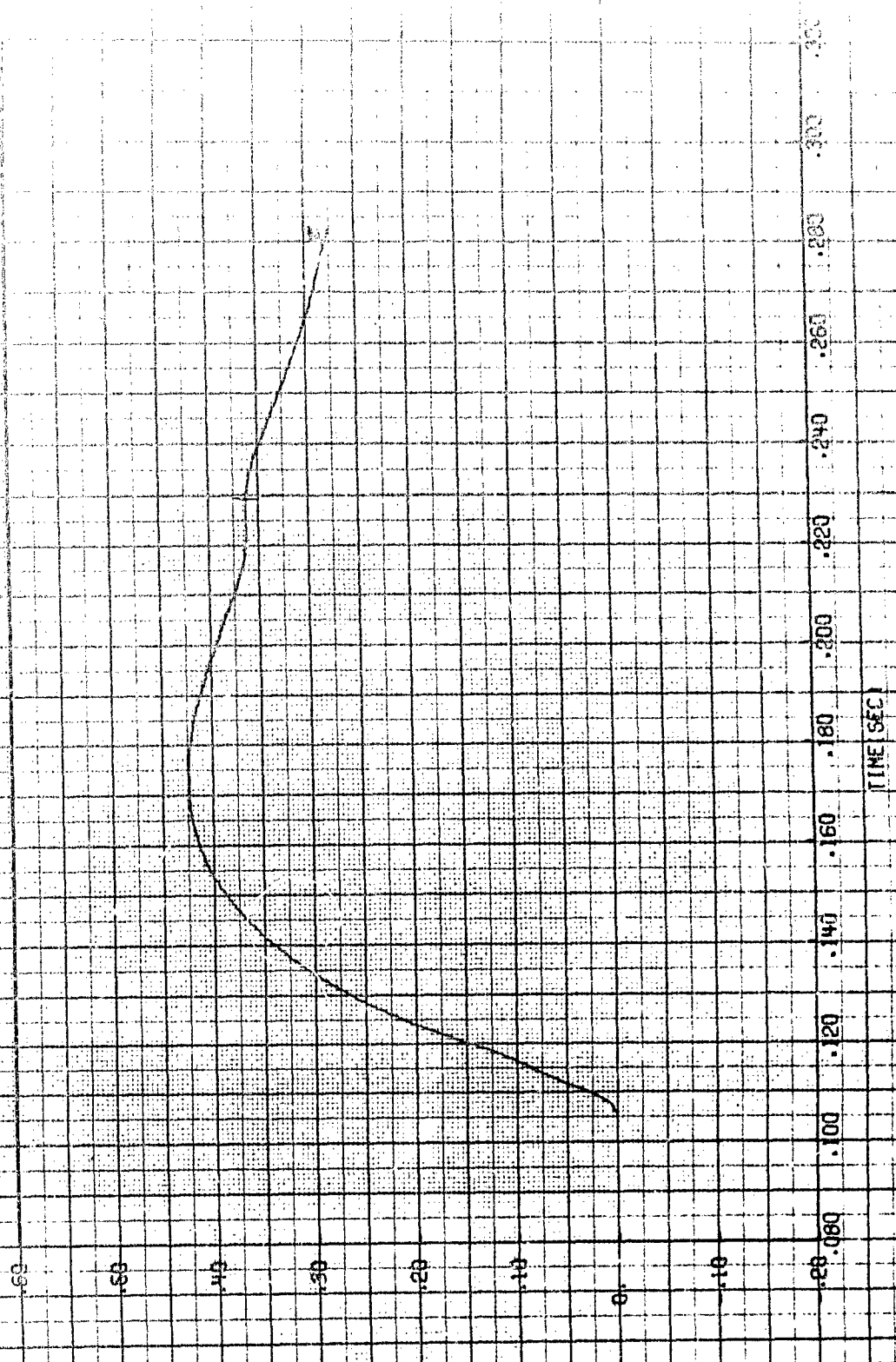
TIME (SEC)

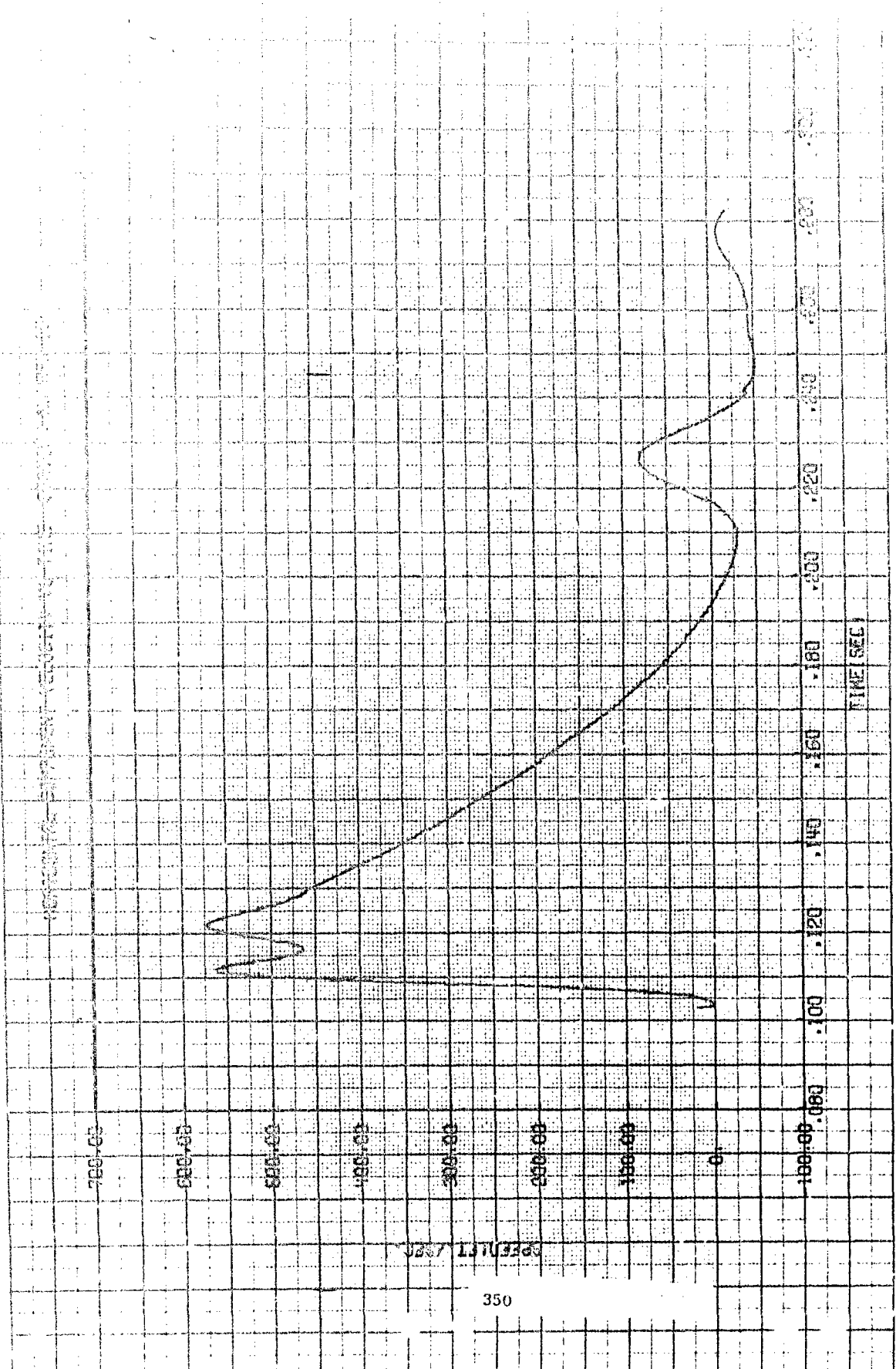


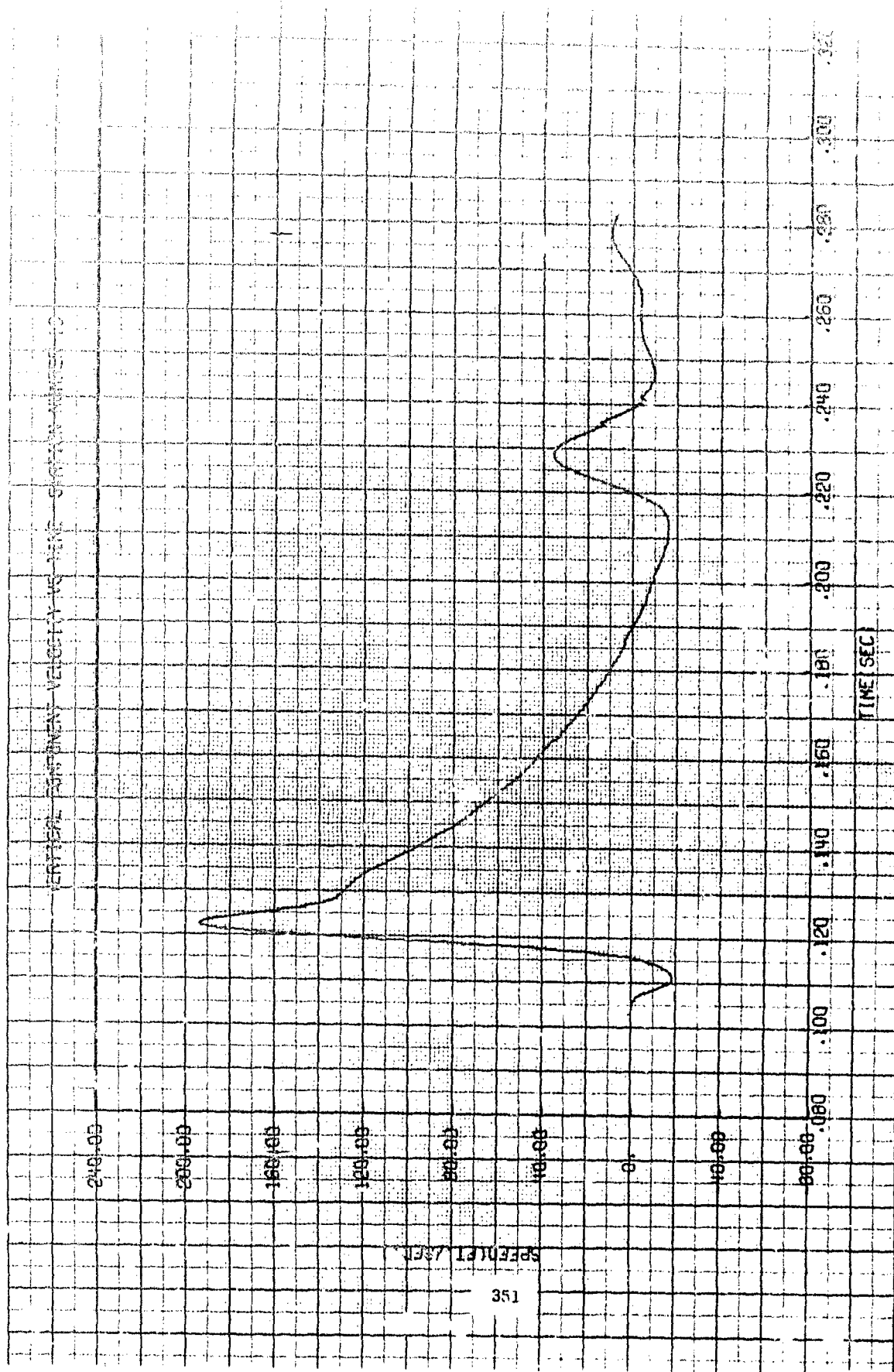
OVER PRESSURE PULSE VS TIME - GUN NO. 1000-10

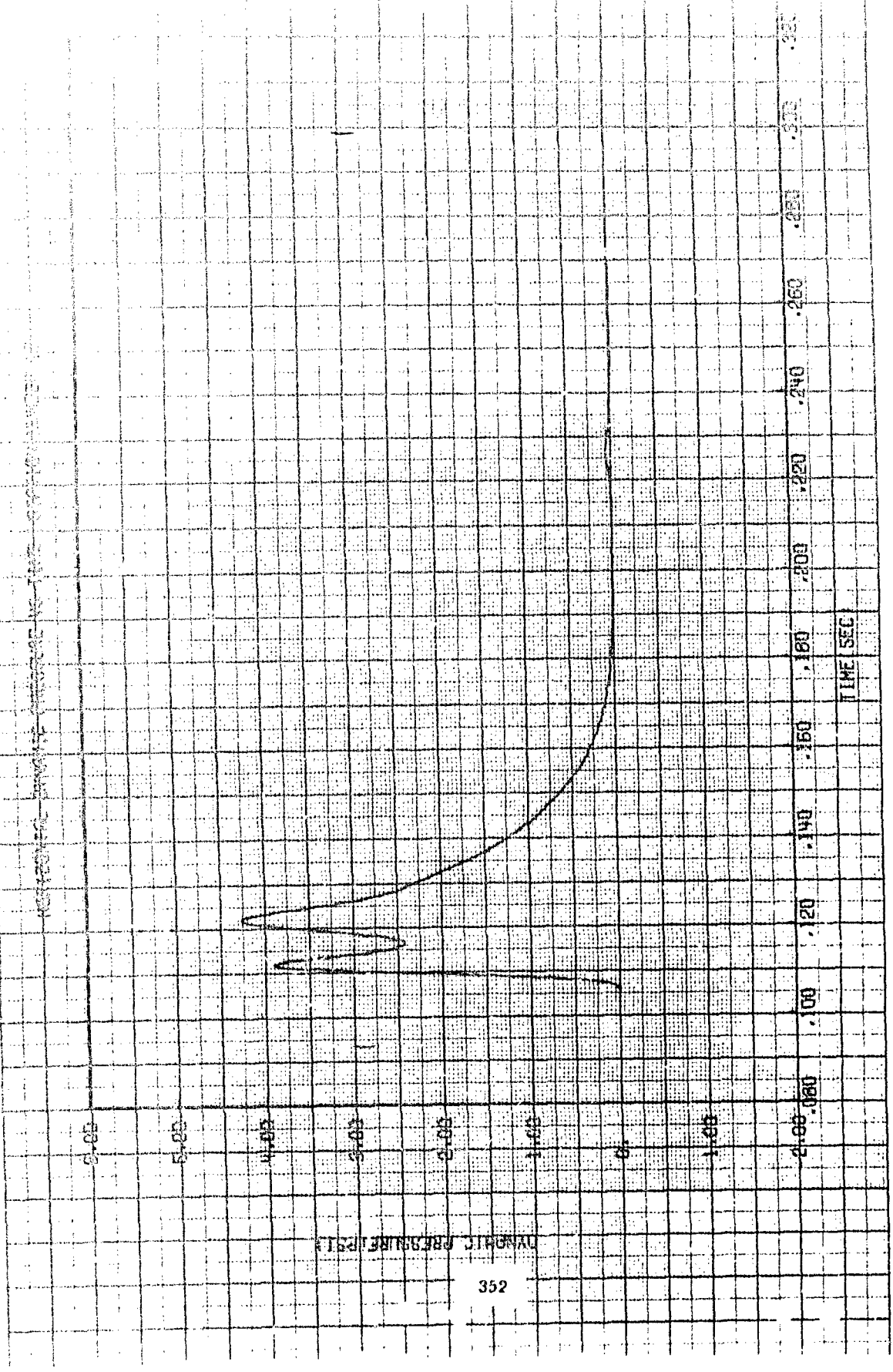
OVER PRESSURE PULSE (MBARS) vs. TIME (SEC)

349

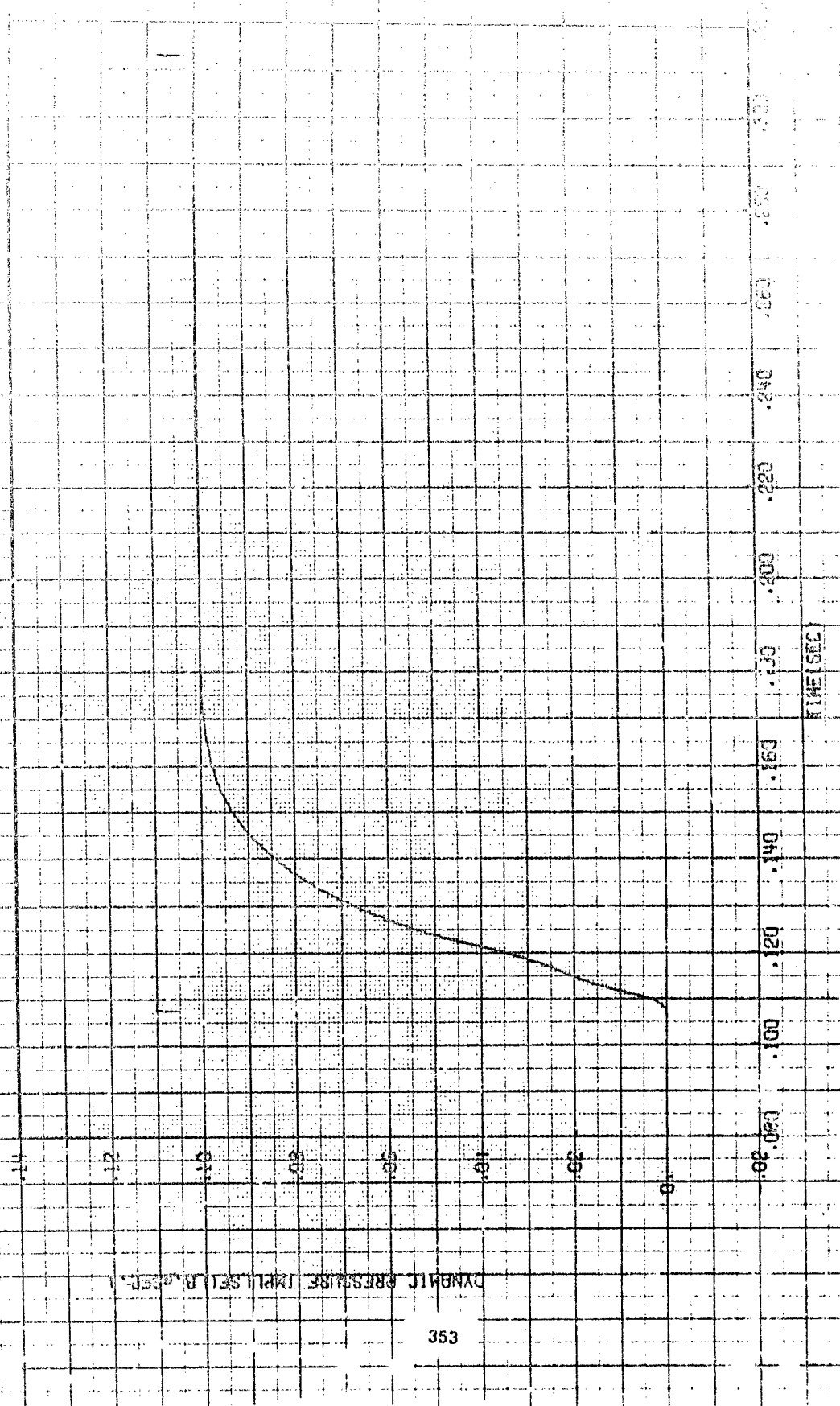




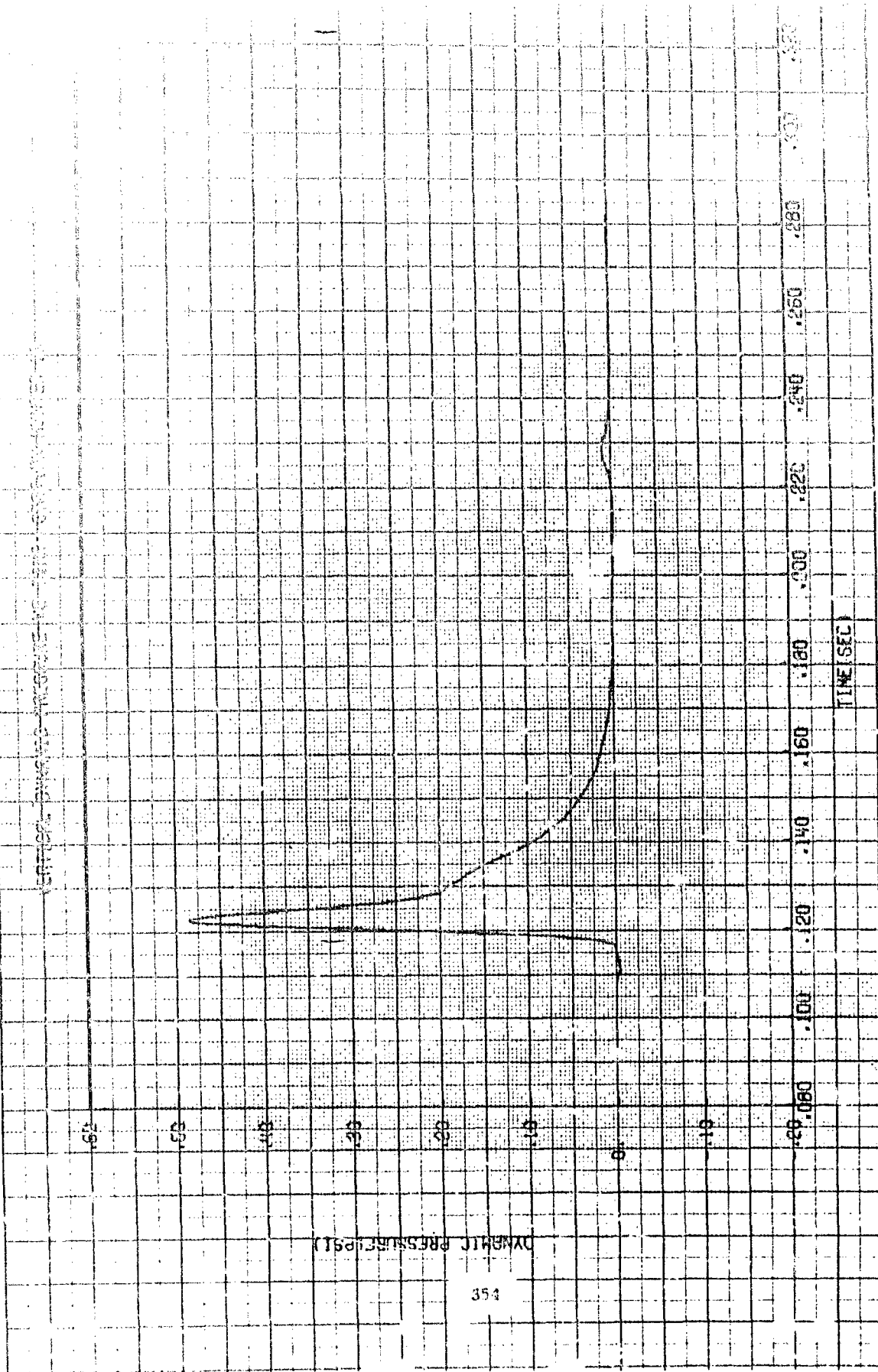




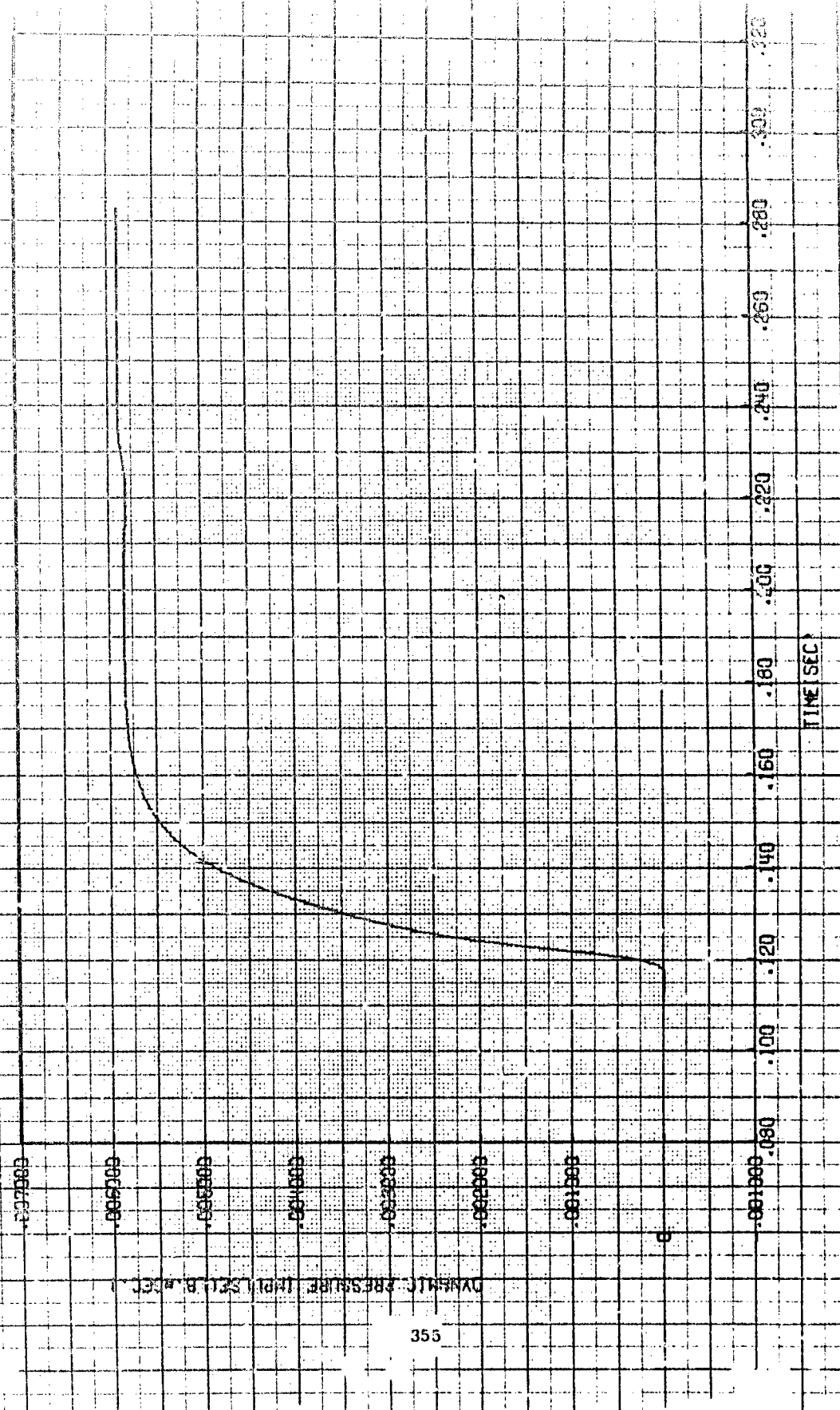
HORIZONTAL DYNAMIC PRESSURE IMPULSE VS TIME (STATION NUMBER 13)



DYNAMIC PRESSURE IMPULSE (LB/FT²) vs. TIME (SEC)



VERTICAL DYNAMIC PRESSURE IMPULSE VS TIME - STATION NUMBER 10



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4. DESCRIPTIVE NOTES (Type of report and inclusive dates) 1 September 1965 to 1 June 1966		
5. AUTHOR(S) (Last name, first name, initial) Whitaker, William A., Capt, USAF; Nawrocki, Edmund A., Capt, USAF; Needham, Charles E.; Troutman, William W.		
6. REPORT DATE November 1966	7a. TOTAL NO. OF PAGES 368	7b. NO. OF REFS
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13. ABSTRACT The phenomenology of two atmospheric high-explosive detonation were calculated theoretically. The first was a 20-short-ton spherical charge of TNT (loading density--1.56 gms/cc). The second was a methane-oxygen mixture (mole ratio 1 to 1.5) contained in a 55-ft-radius balloon. Both detonations took place at an altitude of 670 meters (ambient pressure 13.6 psi) with a reflecting surface 85 feet below burst point. The calculations, taken out to 300 milliseconds after detonations, were performed by using SAP, a one-dimensional Lagrangian hydrodynamic code and SHELL-OIL, a two-dimensional pure Eulerian hydrodynamic code. Volume II of this report contains the details of the results in graphical form. Included are pressure and density contours, velocity vector plots, and wave forms for 19 test stations.		

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Unclassified

Security Classification

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Blast Wave Shock Reflection Sock Reflection Triple Point HE Detonation, Calculation of SAP SHELL-OTL						

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SUPPLEMENTARY

INFORMATION

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AF Weapons Laboratory, RTD (AFSC)
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12 April 1967

ERRATA

AD-803657
AFWL-TR-66-141,
Volume II

"THEORETICAL CALCULATIONS OF THE PHENOMENOLOGY OF H.E. DETONATIONS," Vol. II, Unclassified, November 1966, by William A. Whitaker, Capt, USAF, et al.

1. Replace pages 5 through 29 with the attached pages 5 through 29.
2. The units for the values appearing in the contour scales in Sections II and III are: grams/cm³ for the density contours and dynes/cm² for the pressure contours.

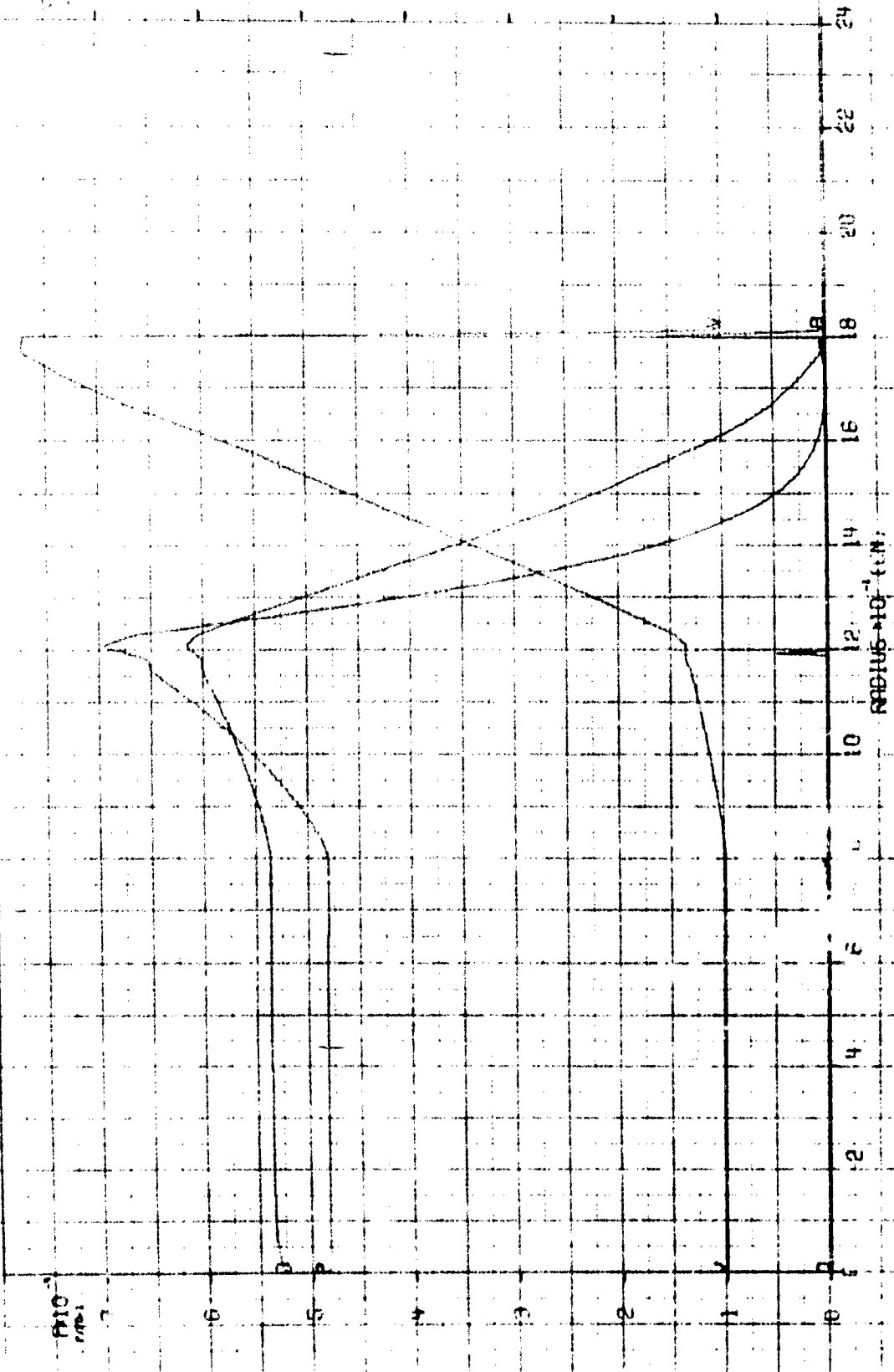
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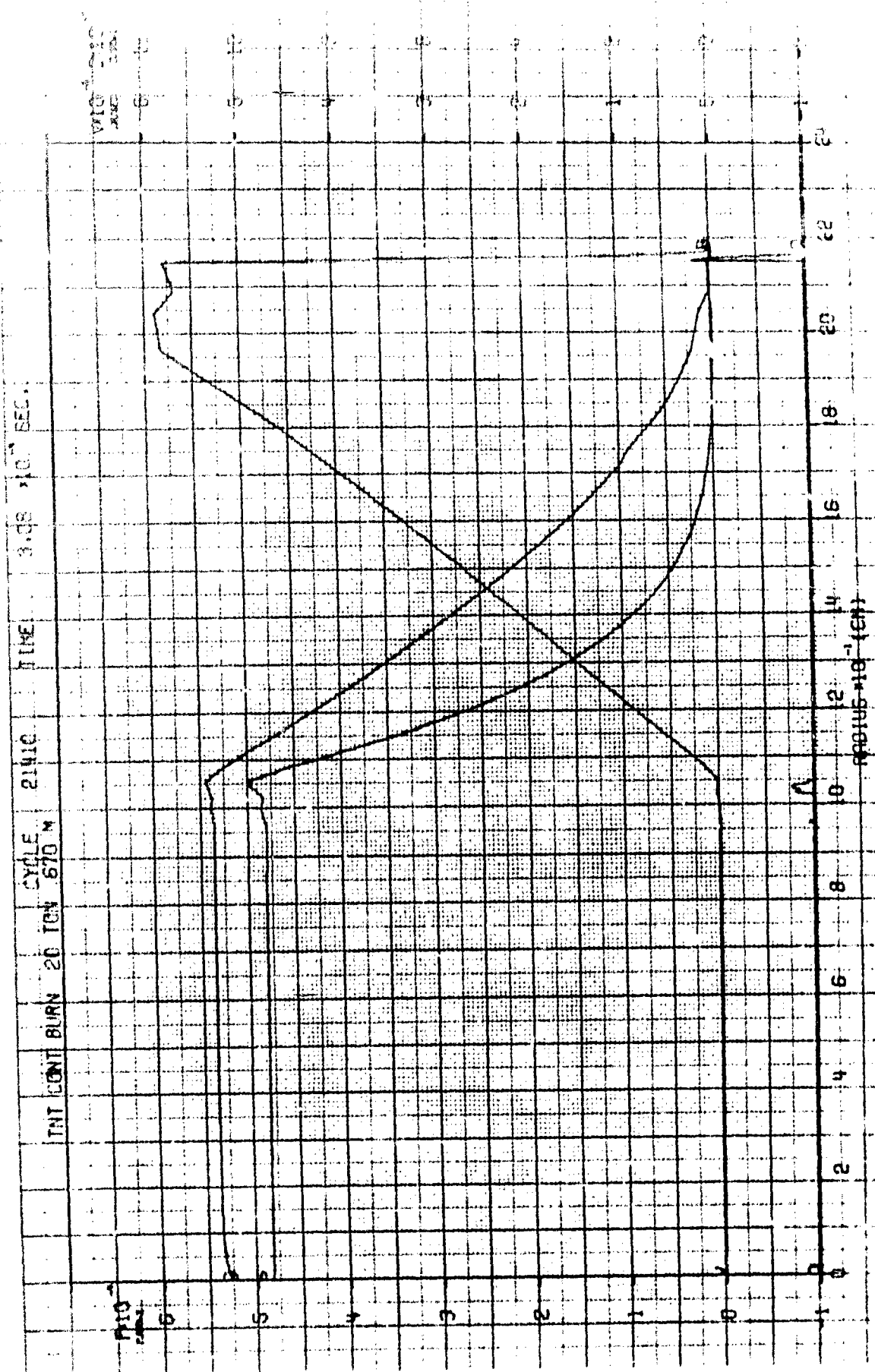
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Captain, USAF
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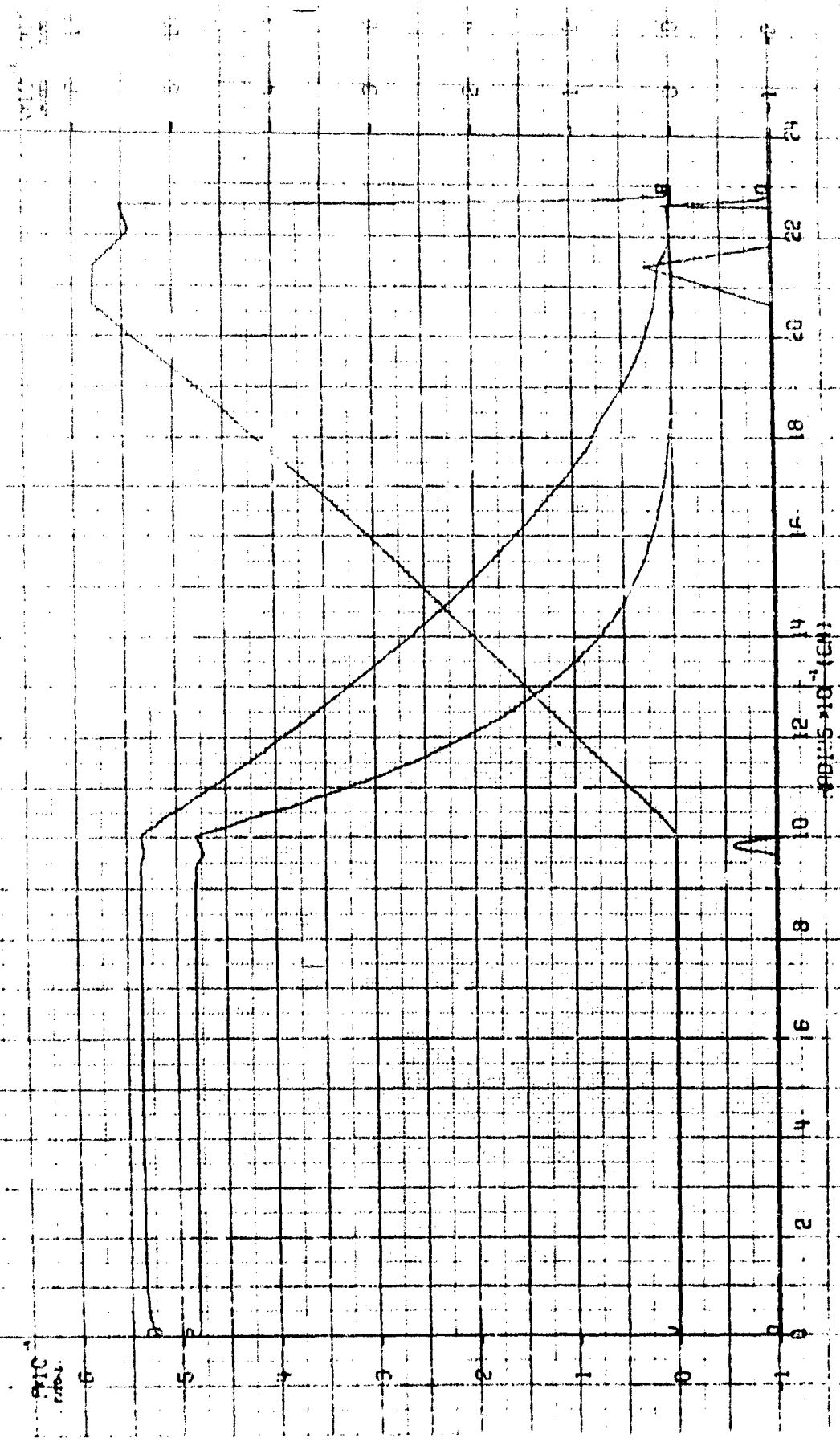
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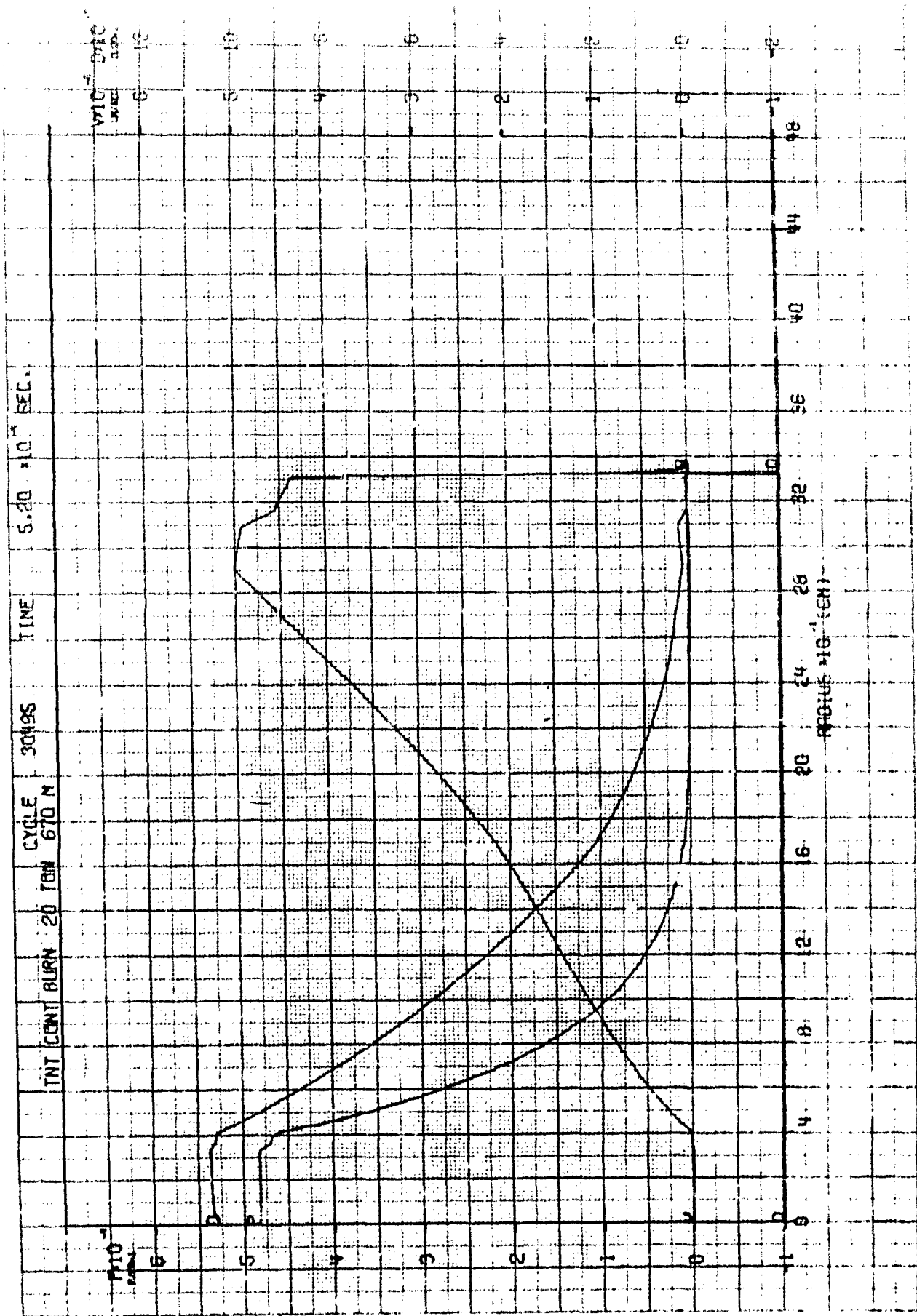
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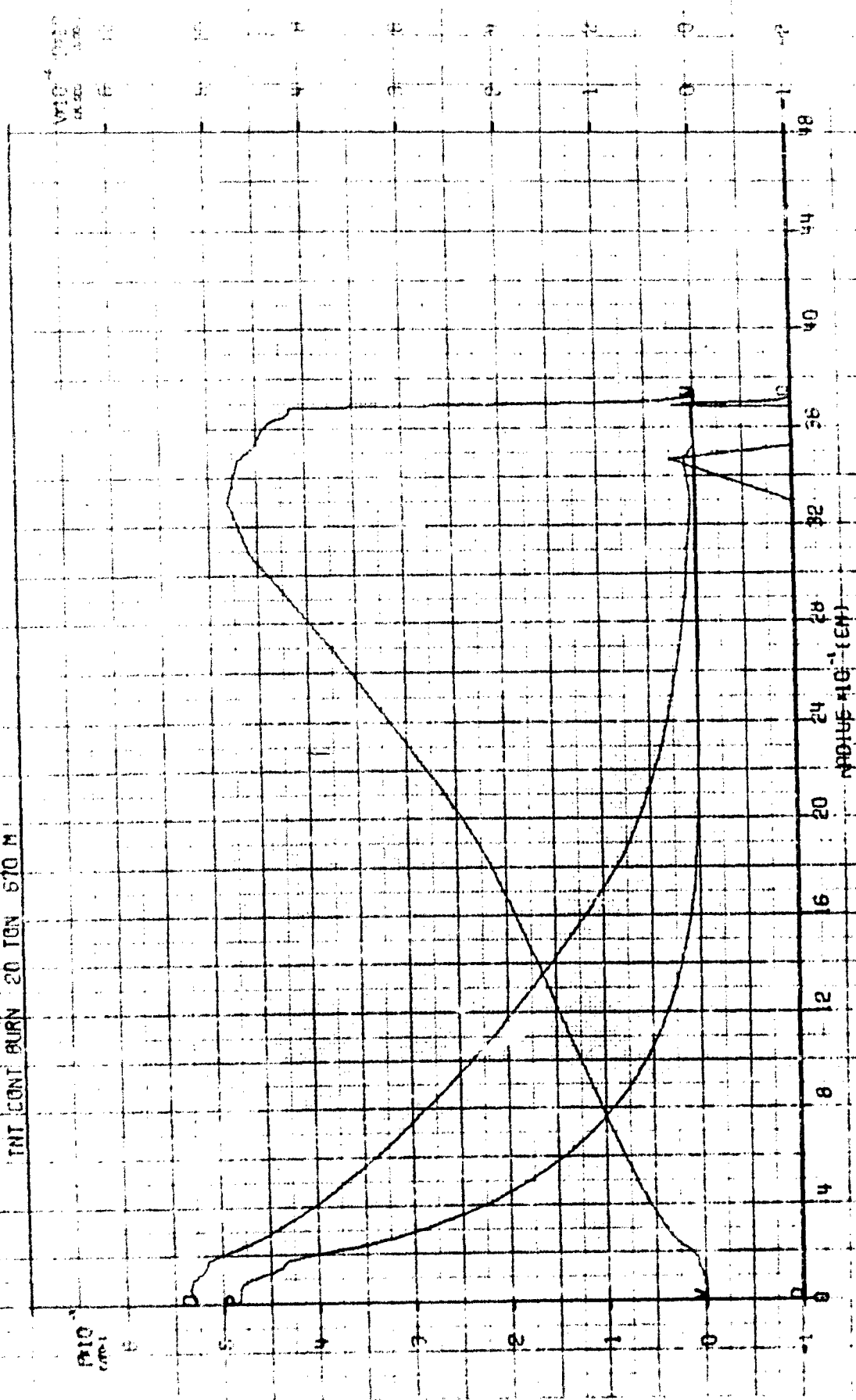


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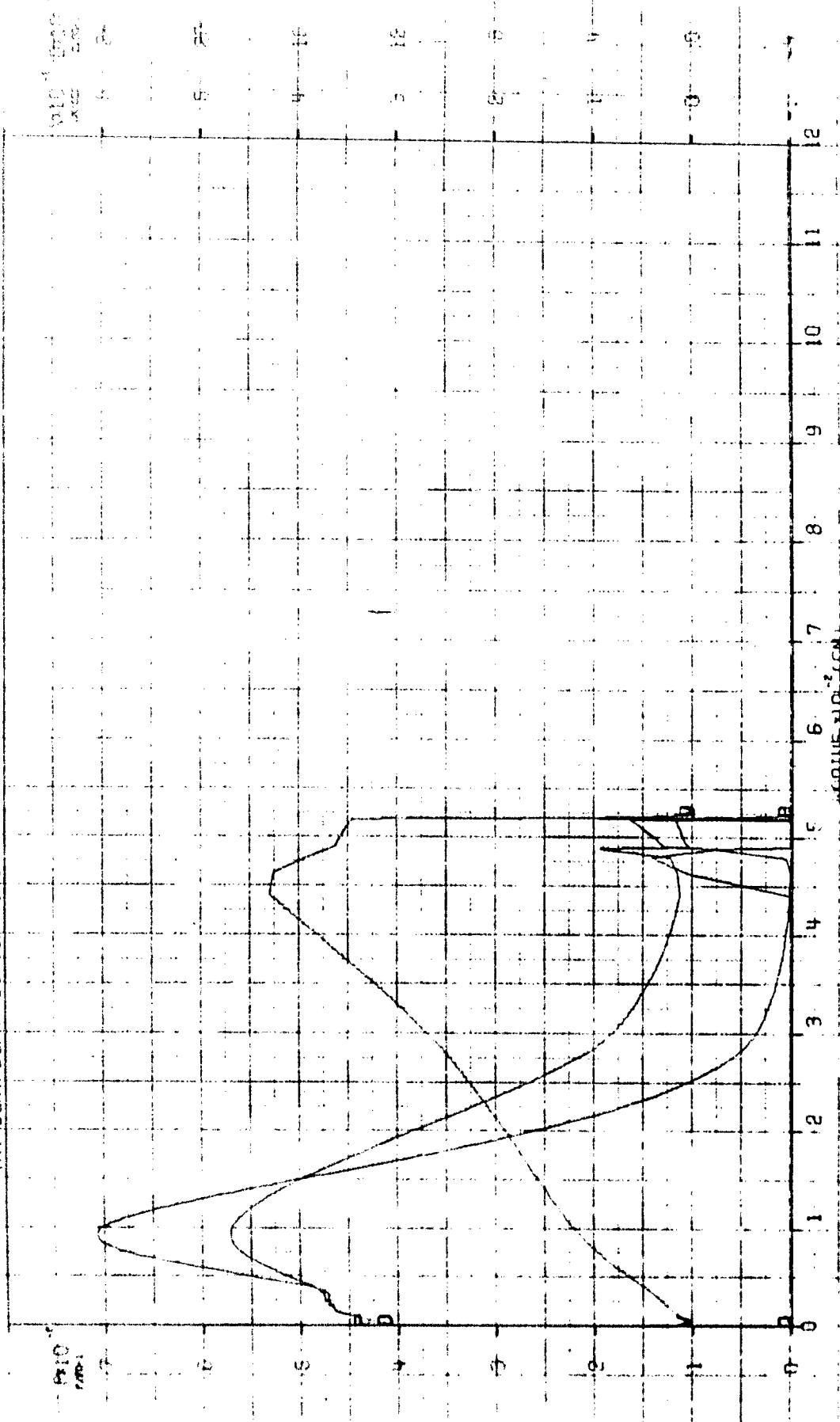


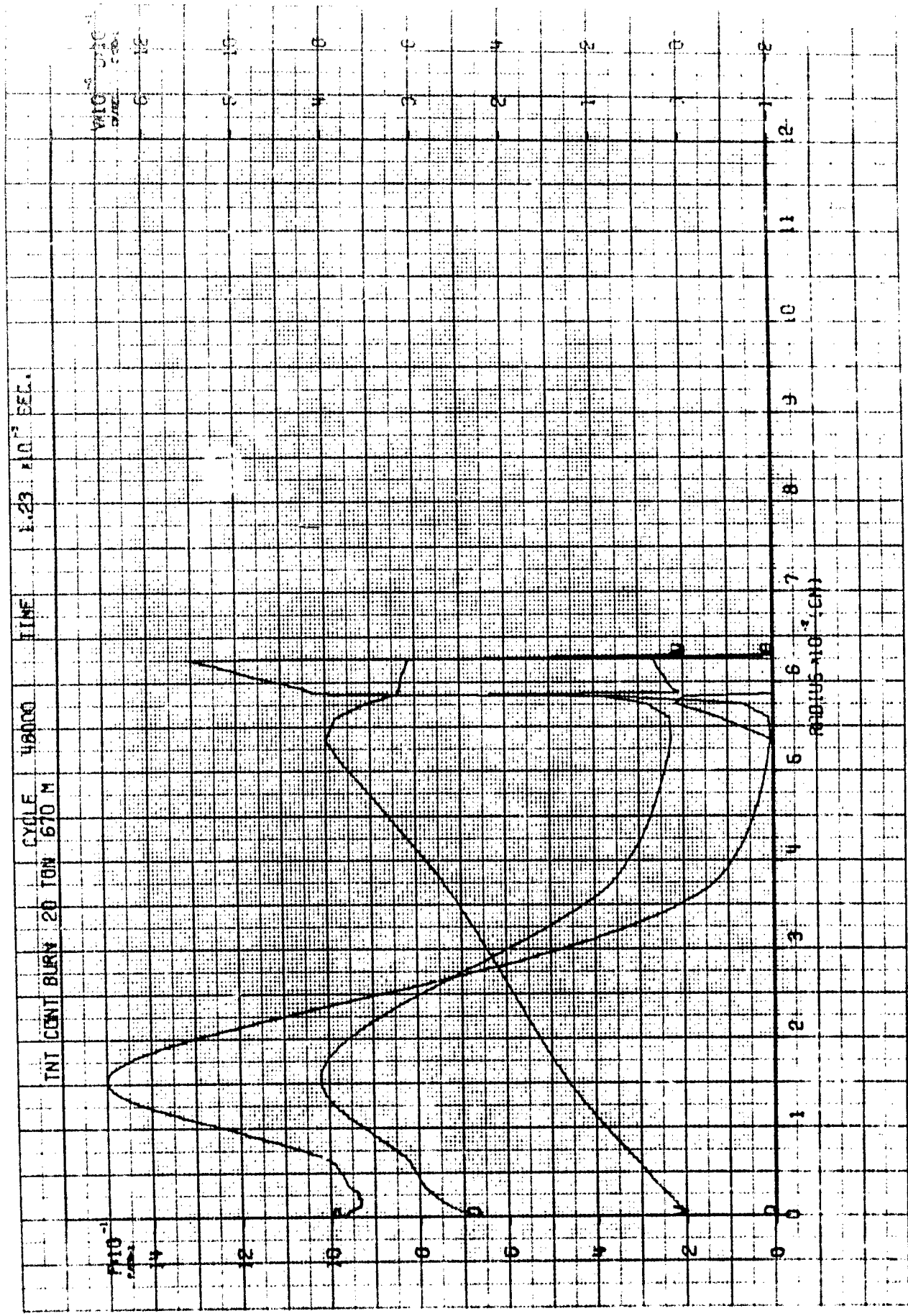
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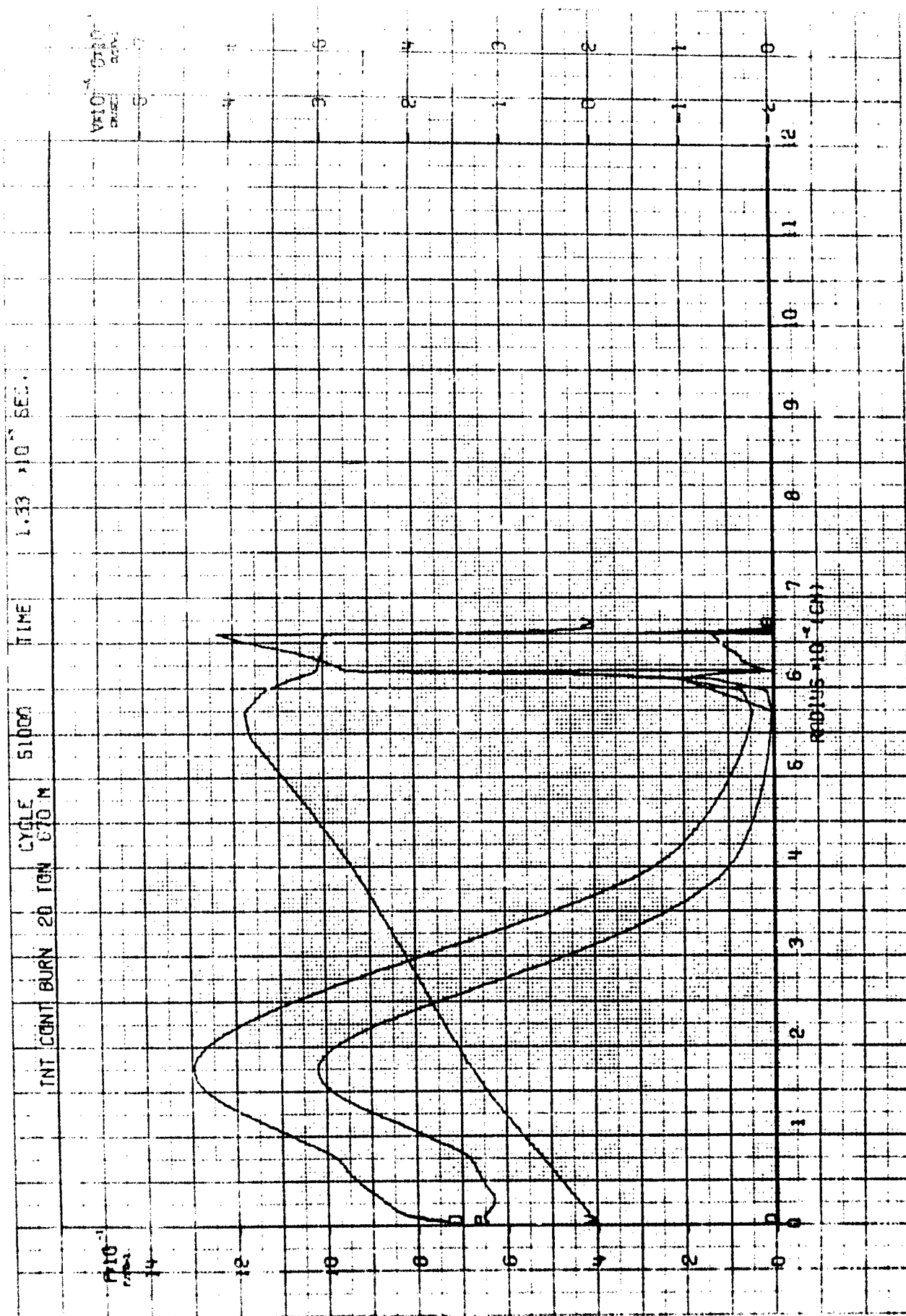


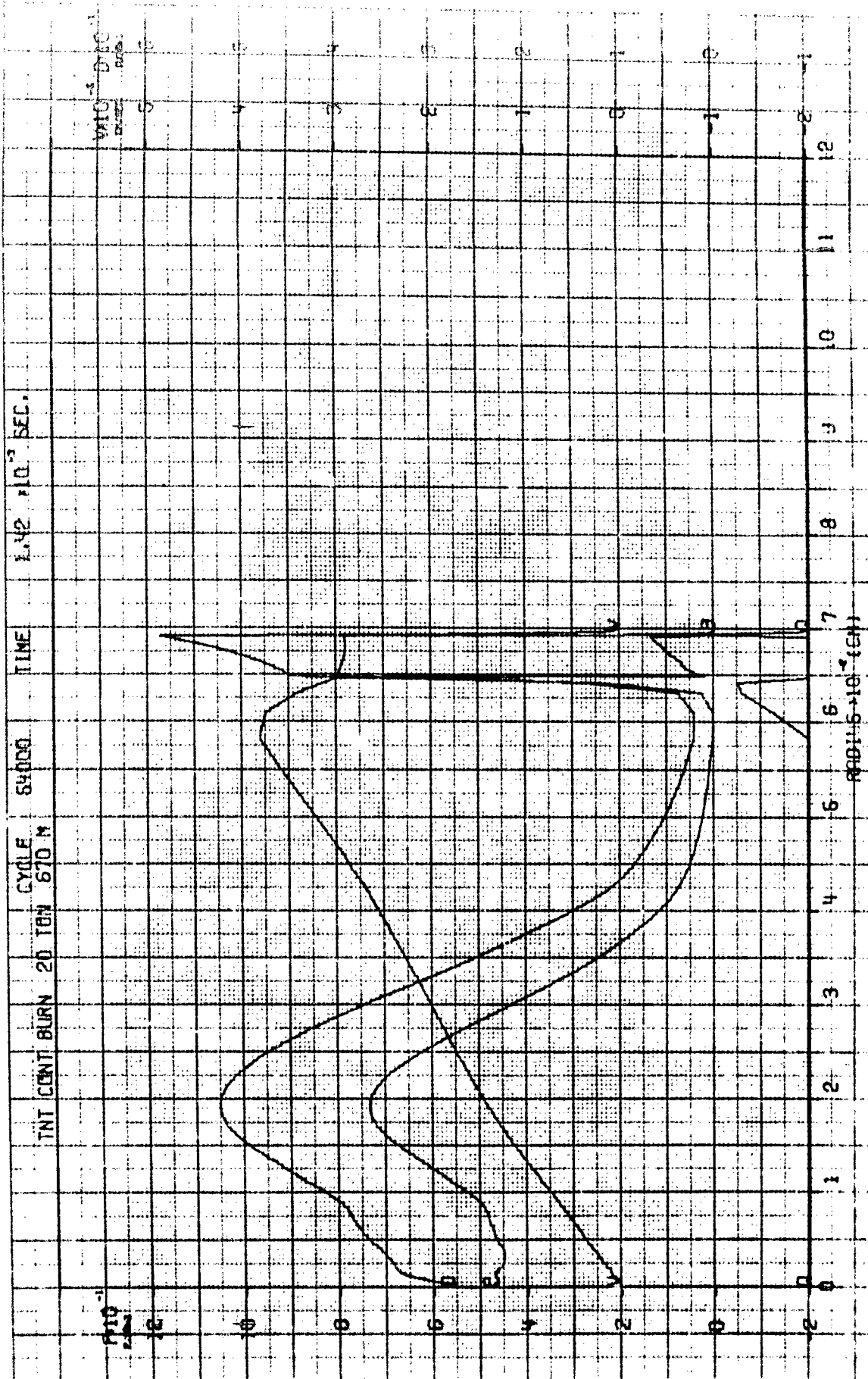


INT CONT BURN 2U1CN 670 CYCLE 3991C TIME 9.91 1.155









TNT CONT BURN 20 TON 670 N

CYCLE 74000

TIME 2.02 $\times 10^{-3}$ SEC.

PTIO $\times 10^{-1}$

PTIO $\times 10^{-1}$

PTIO $\times 10^{-1}$

RADIUS $\times 10^{-4}$ CM

